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EXPERIMENTAL MUSICAL INSTRUMENTS

For the Design, Construction, and Enjoyment of Unusual Sound Sources

TALKING MACHINES AND SINGING KITES

Human speech, from an acoustic point of view, is an extremely subtle business. The vocal tract forms a pliable and ever-changing acoustic resonator, with an infinite capability to shade its tone qualities. Its sounds don't change discretely from one to another as if they were separate letters of the alphabet, but glide continually from one to the next. Our ears, though we don't normally give it much thought, hear it all: to interpret the utterances of others, they are attuned to the tiniest differences in sound quality and inflection.

Given all that, the idea of making a device to convincingly imitate human speech is a challenging one to say the least. But that doesn't mean people haven't tried. In this issue of *Experimental Musical Instruments*, Martin Riches — who has been designing and refining his own modern talking machine — describes four historical attempts at the recreation of speech, ranging from organ pipes and mechanical articulators to early electronics.

Also in this issue we have Uli Wahl's report on traditional Chinese singing kites, with complete instructions for making the on-board whistles. We have from Will Menter an article on the ways of slate. We have more on sirens, this time with an emphasis on the making of simple sirens as musical instruments. We have the first in what will be an ongoing series from Robin Goodfellow on kid-buildable instruments, focusing on their integration into classroom lesson plans. And we have, from Ben Cohen, great ideas for what you see in the photo on this page: affordable, versatile, and effective drums created from large plastic pipe fittings.

...And, as always, much more. So open, and read.

In the photo: Adjustable-pitch doumbek made from plastic pipe fittings by Ben Cohen. See the article starting on page 38.

LETTERS & NOTES

AS A FIRST-TIME READER of *EMI*, your publication covers quite a broad spectrum of unusual and fascinating instruments, sound, music, people and places.

I've just in the last year developed this really strong interest and need for different rhythms, sounds, tones, etc. For some reason it reminds me of being a child visiting my uncle in a monastery. He was a priest and the choir director. My whole understanding of God at that time was the pure tonalities of the monks singing Gregorian chants. It literally filled the skies. (It also gave me the only understanding of God I've ever needed)

Last year in April I was in New York in Grand Central Station, and I was again struck with that same profound sense, when the clear tones of a single pan pipe filled the entire "Cathedral." The contrast of the purity of the tones, with the scurry and essence of Grand Central Station and the subways was just remarkable.

Thanks for the journey, round the world of experimental sound and back again.

— Stacy Keith

SUBJECT: IMPRESSIONS

I am on the couch, it is just after 11:00 P.M. It's a warm night and the windows are open. Sound carries at night. The Bulls have just won number five. I am a witness to a gigantic freeform composition of sound. I am immersed in a city of noise. Cars and trucks like a flight of crazed geese blow their polyphonic horns. Sirens blare and bombs explode in the midst of what sounds like the pandemonium of an army infiltration course. The annual fourth of July noise pales by comparison as wild and shouting aggregates of Chicago fans play and celebrate. The information of winning is bursting from every cheer. We are dazzled and we act like one preposterous tumult. We are giant randomized concert of sound. We are cacophony. Go Bulls, Go Bulls! OUH! OUH! OUH! The sound and the fury.

Man's fundamental nature is not sweet music, it is noise, tension and release. The evidence is everywhere. The background of perpetual noise comes to the foreground in times of high spirit. We unfold and perform our noise in the immediate moment of joy and withhold it day after day in our restrained and proper way. All this noise is music and all this music is noise. Finally, I fall asleep on the couch. It was probably sweet music after all.

— *Grant Strombeck*

IN RESPONSE to Bill Houck's letter in the March '97 issue [describing a box-like, foot-operated, bellows-driven two-note edge-tone whistle], the description and picture he gives reminds me of a cuckoo call I played a couple of years ago. I am a freelance percussionist and sometimes work with the Australian Opera. This often includes playing the back stage Banda and sound effects. The cuckoo call I mentioned was in the opera *Hansel and Gretel* by Engelbert Humperdinck (the 19th century German composer. Not the 20th century American country crooner!). The instrument was made by an organ builder with tuneable wooden pipes connected to two small hand operated bellows producing a high and low pitched note. So Bill may find his mystery instrument is more bird than folk.

— *Tony Cowdroy*

email TeeCee@bigpond.com

OK HERE GOES. The driving force of a lot of your contributors' articles, especially the ones that interest me, are ways of changing traditional instruments or making newer simpler, more user-friendly instruments to make music making easier. This all boils down to the truth most musicians know all too well, that making music is a lot simpler than playing instruments, and the unfortunate corollary that instrument instructors are many, music teachers few. Having been at one time a professional trombone player (Port Jervis City Band — Sousa marches on the band shell, Memorial Day Parade et. al.) the article by Bart Hopkin and Philip Ostendorf on his attempts to make a natural horn without valves — lip-controlled several register fully diatonic brass instrument (*EMI* March 97) — was fascinating. To try in the end to make these horns fully chromatic by adding a single hole seems to me to be a mistake. I made a six hole conch on which I could get a diatonic octave and a half, but holes on a horn do not seem to work as well as on woodwinds. Why? In the playing they seem to be sloppy and not well defined, with a lot of lip work necessary to center the tone. Nobody plays the serpent anymore, an early squiggly horn with finger holes. Although I'm sure he's constitutionally opposed to it, if Mr. Ostendorf really feels compelled to make them chromatic, one valve altering the fundamental tone one half step would probably work best, and be still much simpler than the traditional arrangement. Or would this create an interference with his bell resonance tubes? [editor's note: Phil Ostendorf does use valves to make the half-step change in the fundamental in cases where he has modified an instrument already equipped with valves. His use of the single tonehole in other cases may simply be a matter of expedience since valve making for brass instruments requires special manufacturing equipment probably not readily available to him.]

I am presently working mostly with string instruments and piezo pick-ups on the Gravikord® (*EMI* April 1988), an electric diatonic double harp. You make a perfect simple diatonic instrument and you hesitate to make it overly complex for the odd pieces that require key changes and chromatics. Ninety-five percent of the tunes in most people's heads are straight diatonic melodies. On slow pieces I get the accidentals sharping the strings koto-style by stretching the string from behind the bridge. But I too heard the chromatic muse and was in essence dealing with the same problem. Although this does not apply to horns, I think it would be interesting to many of your readers to know how I made a diatonic instrument functionally chromatic. After many attempts at string-stretching and bridge-moving mechanical designs which worked, but were problematic since each string length is different on the Gravikord giving you a choice of getting some notes in perfect half-step tune while others were simultaneously at all sorts

of microtonal intervals, this was OK if you're playing a single-note melody line or avant-garde trash, but that's not what interests me, I like polyrhythmic chordal progressions. I finally solved the problem electronically by using a phase shifter set at a one half step interval and at 100% effect with a momentary contact foot pedal on the effect remote. This either sharpens or flats the whole instrument a half step (or whatever you set it to), the equivalent of stepping on all the pedals of a classic orchestral harp at once and sounding a little like a bottleneck harp. You can hear the results of this on a piece from my latest recording *Cherries and Stars* called "Accidental Etude." This setup will work for any amplified system. And it works well since, using the piano analogy, sliding all the white keys up (or down depending how you set the foot pedal) a half step covers all the black keys. Since my instrument is totally electric and not acoustic, it does not sonically interfere with itself during the pitch shifting, in addition even in quick rhythmic changes the dissonant tones do not mix since stepping on and off the foot switch is also the equivalent to stepping on and off the dampening-sustain pedal of a piano.

All of the above leads me to a suggestion for your magazine. You should have an ongoing Q&A column for readers to ask basic questions about music, musical instruments, and acoustics which the editor I'm sure would enjoy answering. Ones like the following:

1) After mulling about the above horn/woodwind difference for several days I started wondering deeply about some basic stuff. Since both horns and woodwinds are instruments of vibrating columns of air, why do horns need only seven variations to be fully chromatic while all woodwinds have such complex hole and keying structures? As I said this is not my real area of focus these days and perhaps I'm missing some basic fact, on top of this I can't find my handy *EMI* wall chart with everything you want to know about instruments, but anyway, on the trombone there are seven slide positions and horns have seven combinations of valve fingerings. These raise the lowest tone chromatically (by half steps) up to the augmented fourth. For a horn whose fundamental is "C" in the trombone in first position, slide fully withdrawn, a horn with no valves depressed, these notes would be C, C#, D, D#, E, F, F#, the fifth which is the next note in the chromatic scale is present as a natural resonance of the fundamental tone with the horn in the "C" position, i.e. the trombone in first position, slide fully withdrawn, a horn with no valves depressed. Horns naturally go from the fundamental to the perfect fifth interval like when playing "Taps," yet this basic resonance does not seem to exist the same way in woodwinds. When over blowing woodwinds they jump to the octave, skipping the fifth. Why? Once at the fifth the rest of the chromatic scale in horns is a repeat of earlier positions or valve combinations at the new resonance. The perfect fifth is a basic resonance in the harmonic series, in a string it is the one with two nodes, i.e. one-third the string length, the whole string vibrating as three waves. It seems to me that if this resonance could be established in flutes, saxes, etc. (perhaps in some way analogous to Ostendorf's work) they would need only six holes to be fully chromatic instruments like the horns, instead of the complexities we have today. What's wrong with this picture? Or, I guess the basic question is why are horns and woodwinds so different?

2) The first part of your article on sirens, *EMI* June 97, also raised some interesting questions for your future Q&A column. The first hands-on siren I ever had was an old horn from a Model-T Ford. This was basically a round can with a spring loaded plunger in the middle and a very short horn on the front

IN THIS ISSUE

EXPERIMENTAL MUSICAL INSTRUMENTS
For the Design, Construction and Enjoyment of Unusual Musical Sound Makers

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in the center of which was some sort of plate and adjustment screw. You pressed on the plunger, I guess in the car you probably stepped on it, and out came this very loud marvelous "aa-oooo-gaah" sound. How did this happen? This seems like it must have been a more complicated system than the simple sirens you just described in such loving detail. Can you enlighten us on this matter?

3). Also in that article you mentioned that mechanical sirens are becoming obsolete and the things we hear on modern urban emergency vehicles and car alarms are entirely electronic and "use piezo-electric transducers as the noise producing element." I use piezo-electric pick-ups in my work and many people are familiar with them in phonograph needle cartridges and in instrument contact mics, and if I don't think about it too deeply I seem to understand how a vibrating quartz crystal produces a corresponding weak electrical signal. But how do you get quartz crystals to scream out loud? A short description of piezo-electric speakers might be interesting.

4.) In the same issue, Susan Rawcliffe's review of the NAMM show was right on target, especially her first sentence —"Make no mistake about it, this show is about money, not about music." Over the years people have told us we should be in the NAMM show with the Gravikord, so we became curious about it. In 1994 we thought we had connected with La Bella Strings, a commercial manufacturer, to share a booth and act as a draw. We made arrangements but they backed out with some excuse at the last minute. This is a good idea to be part of someone's booth if you can make it work, as the booth fees are very high and you are competing with Yamaha and Roland and all the names we all know, so even if you pay over $1,000 for a minimum booth of your own, you wind up in a backwater location under the stairs.

And there are lots of these as the Anaheim Convention Center is an enormous place. We went anyway just to see what it was like. This is strictly a trade show and the general public is not allowed in, but as White Bear Enterprises and manufacturers of the Gravikord, a musical instrument, after paying a fee of $150 we were allowed in on a one day pass. I was carrying my instrument in a case on my back and on the way in someone asked me if I wanted to check it, I said no. You get the flavor of the show from Susan's article, it's where the big boys show off their latest toys for music store buyers and wholesalers. The biggest manufacturers have huge sexy displays and sound-proof concert stages where name acts perform on their products at scheduled times. For all of this they pay extra, I can't imagine how much. Anyway Pip and I are walking around in OZ when we see some poor lonely amplifier manufacturer being basically ignored, sitting beside a pile of silent black boxes. Pip with a big smile walks up and says, "We have a new electric harp and we'd like to see how it sounds on you're amps?" He says, "Sure." I start playing, immediately a big crowd forms around us, "What's that?" Pip's handing out flyers, the Amp man is talking to rows of backed up customers explaining his new line. Someone taps me on the shoulder, "When you're done here, would you please come down to my booth and try out our new amplifiers?" This happens all day! We are moving through the whole show from the back door of the last building to center of the main domed room. We are busking the NAMM show! People love the music, Pip's handing out flyers and selling recordings. What's wrong with this picture??? At the end of the day we are in the middle of the biggest hottest sales area in the whole show playing the Gravikord to very appreciative audiences for a major amplifier manufacturer who asks us to come back tomorrow and play all day!

If only I had left the instrument at his booth we would have had it made. Instead I decide to take it home for the night. At the exit I am interrogated — Where's your pass? — What pass? — You can't take anything from the show site! — But I made this, this is my instrument! — You'll have to report to the office immediately! — It was like going to the principal's office in high school. We told them we were manufactures and just came for the day, we didn't know that we weren't allowed to bring anything in from the outside, we said we were sorry and they made us promise we wouldn't do it again. They gave us a pass so we could leave with the Gravikord. They never knew what a fracas we had created and we never told them that we had been playing all over the show all day. The magic was that we didn't know at the time that we were pulling off a scam, and the Gravikord was so obviously someone's new entry into the big commercial world of NAMM, it fit in so well that none of the officials ever questioned us all day. The amp manufacturers would have had to pay a large extra fee to have live performers demonstrating their equipment at their booths and they would also have had to pay these performers and arrange for their passes, etc. so of course they were happy to see us coming along. We got the pass, left, got into our car and drove away screaming our heads off. We haven't been back since.

Pip just suggested a co-op *EMI*–(Ellipsis ?) booth at future NAMM shows. There are music business publishers represented at the show, with a variety of any of your contributors who are seriously trying to make and popularize a new instrument at one booth sharing the fees, it might make the commercial people take notice. But, knowing them, they'd probably just start making cheap knock-offs of the better ideas, since they have the distribution, advertising and legal budgets covered. It's just an idea, if anybody out there is interested. It would certainly make the NAMM show less bland, not that that's any great concern of mine.

— Bob Grawi

From the editor: Since we don't have a Q&A column in place at this time, I'll give my thoughts here on the questions Bob Grawi raised in his letter. But I'll do it in small type so as not to take up too much space on the page.

1. Why do horns (that is, lip-buzzed brass wind instruments) typically overblow the fifth above their fundamental while flutes overblow the octave?

Typical flutes function acoustically as cylindrical tubes open at both ends. Without going into the whys of it, such tubes have natural resonances at pitches corresponding to the harmonic series. Thus, playing a flute with all the holes covered, using changes in embouchure (perhaps assisted by a venting hole), it's possible to produce the tones of a harmonic series — fundamental, octave, twelfth, two octaves, two octaves and a third, and so forth up to the point where it becomes too difficult to get the flute to speak the tones. Thus, as Bob notes, the flute requires elaborate keying mechanisms to fill in the 12 chromatic tones between the flute's lowest note and the next note it can overblow, an octave above. We can add that, in contrast to flutes, clarinets function as cylindrical tubes closed at one end. Once again without going into the whys of it, they produce only the odd numbered harmonics — fundamental, twelfth, two octaves and a third ... so, to fill in the even larger gap from the fundamental to the twelfth, clarinets require still more elaborate keying systems. The situation with brass instruments is a little muddier. Typically, brass instrument forms deviate from simple conical or cylindrical bore shapes enough to throw the harmonic series out of whack. Once again I'll bypass the whys, in this case because the whys are subtler and I don't have a good grasp of them myself. The result, in any case, is that typical brass instruments are not capable of producing a satisfactory tone at the pitch that would normally be thought of as the fundamental of the instrument's overtone series. The remainder of the series, however, is present. It's as if the instrument has a harmonic series starting with what would normally be the second member of the series instead of the first. This leaves the smaller gap of a fifth between the first and second available tones, which can be filled by just six valve

combinations or slide positions. Bob suggests that if flutes and saxes could be made to behave like brass in this way, they wouldn't require such elaborate keying systems. In fact, they can be made to do so, by ignoring the first register (the fundamental register), and playing only the second register (corresponding to the octave harmonic, with its shorter leap to the next register a fifth above) and up. Some flutes have been made with this in mind; such flutes would typically have relatively long, narrow bores.

2. Bob asks how the old ah-ooh-ga horns work. I've never held one in my hands myself, and I too would love to know how they work. I bet this is a question some readers can help us with.

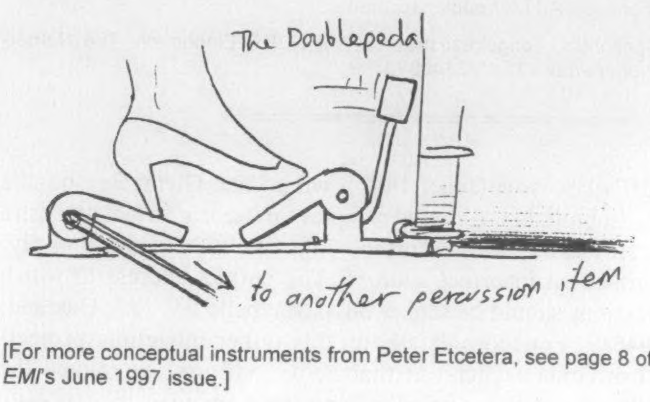
3. In connection with electronic alarm systems, Bob suggests that "a short description of piezo-electric speakers might be interesting." Many musicians are familiar with piezo-electric pickups. These are pickups that function as contact mikes: affix them to a vibrating body, such as the soundboard of a string instrument, and they generate a small voltage fluctuation in response to pressure changes resulting from the vibratory movement. The pattern of this electronic signal is an analog of the vibratory movement, and it can be sent to an amplifier and speakers for an amplified sound. It happens that the process works in reverse as well: if you send a fluctuating voltage to a piezo-electric crystal, it will respond by changing shape in time with the fluctuation of the voltage. With the right sort of design, the resulting movement of the crystal can be used to drive a diaphragm which, with its greater surface area, moves the surrounding air in a manner analogous to a loudspeaker. But unlike a loudspeaker, due to certain properties of the crystal, such systems are far better at producing a single specific frequency with great efficiency than they are at reproducing a wide spectrum of frequencies. That's why they are well suited to alarm systems, where efficiency is important, and unbiased frequency response is not.

4. About the NAMM Show: Great story.

— Bart Hopkin

I SAW SOME of your March '97 issue with the drums and hammer kick-pedal ["Industrial Waste and Musical Taste," by Keith Spears] and it reminded me of my other designs: The Drumball was inspired by those mounted marching-band toms and the Double Pedal was inspired by simple ergonomics. (When we tap our feet on the floor we use our heels separately from our ballfront. With the D-pedal you can hit 2 drums of any kind, simultaneously or separately. My X-Drums have 30 foot pedals! X = "Excessive.")

— Peter Etcetera



[For more conceptual instruments from Peter Etcetera, see page 8 of *EMI*'s June 1997 issue.]

NOTES FROM HERE AND THERE

A NEW INTERNET MAILING LIST FOR MUSICAL INSTRUMENTS: Dr. Guy Grant (Bigfoot Music, 127 Sorell St, Devonport, Tasmania 7310, Australia; Fax 61 3 64 24 4957) sends this information on the new *oddmus* e-mail list:

People interested in experimental, ethnic and unusual musical instruments are invited to join the free e-mail list *oddmus*. To subscribe to oddmus go to the Coollist Main Page at http://www.coollist.com/, then enter your name and e-mail address at the bottom of the page. Post to oddmus about your ideas, inventions, musical instruments, museums, instruments and CDs for sale, notices of TV programs, movies, overtone singing, yoiking, and anything else of interest. Tell oddmus about yourself and your music.

THE TRUTH ABOUT LIFE: In *EMI*'s June 1997 issue, in the "Notes from Here and There" section, we ran a photograph and some text on a small electronic musical sound device called LIFE. Unfortunately, we got some information wrong. LIFE was not developed by Longwave Instruments as indicated, but by TechnoMage.

An important companion component to LIFE is a device called BOB. TechnoMage's Grant Stephens adds this information about BOB:

BOB, the Break Out Box, connects to LIFE via a cable which plugs into the base of LIFE. The following are then available via BOB: LIFE audio out, Trigger Out (0 to +7.5 v), Trigger In (anything positive between 3 and 15 volts) and Audio In — any audio signal can be processed through LIFE acting as a sort of filter. BOB also has a power On/Off switch (turns LIFE & BOB on and off, enables BOB to be left connected to LIFE).

The photo of LIFE appearing in the last issue was taken by Grant

EMI's VOLUME 12 CASSETTE AVAILABLE NEXT MONTH!

The latest in *EMI*'s annual cassette compilation series will become available around the first of September. The cassette, titled *From the Pages of EMI* Volume 12, will present the sounds of instruments discussed in *EMI* over the last year — that's the four issues dated September 1996 through June 1997. A wonderful mix of instruments will appear, including Nelly van Ree Bernard's reconstruction of a medieval psaltery, Jan Jarvlepp's symphonic junk instruments, Mitchell Clark's shell trumpets, Jacob Duringer's Monolith, Ángel Sampedro del Río's bamboo saxophones, Keith Spears' industrial drum set and sampler table, Colin Offord's mouthbow and other instruments, Rainer Linz's computer realizations of Grainger-like sliding tone music, Grant Strombeck's lots-of-things, Reed Ghazala's circuit-bent digital keyboards, tENTATIVELY, a cONVENIENCE's Terrence Dougherty, and possibly a couple more instruments not yet confirmed at the time of this writing.

The Volume 12 cassette is available from *Experimental Musical Instruments* for $8. See this issue's Notices section(page 31) for details. You can order any time now; we'll send the tape around the start of September.

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Stevens. For more information on LIFE and BOB, contact Grant Stevens at TechnoMage, Woodcote, Tremont Road, Llandrindod Wells, Powys, LD1 5DA, UK. Tel: 011 44 1597 822138; or e-mail grant@powys.gov.uk.

HET APOLLOHUIS CLOSED

In February of this year the Dutch venue for innovative art and music Het Apollohuis was forced to close its doors after seventeen years, due to a decision by the Ministry of Cultural Affairs to cut its funding. From 1980 its founder and director, the artist Paul Panhuysen, presented an extensive program of exhibitions and concerts. From the very beginning he juxtaposed visual art and music by having concerts take place in the exhibition spaces. Panhuysen presented people who had an exploratory approach to their work, people breaking through barriers set by conventions in art. In the concerts one could see musicians specializing in extended techniques, using advanced electronics, venturing outside the territory of music proper, playing instruments of their own design and making. Het Apollohuis was the only venue in the Netherlands to present a wide-ranging program of new music exclusively. In its exhibitions Het Apollohuis became the leading venue for sound art, in which the visual and the sonic are integrated — a territory that Panhuysen himself had already been exploring in the 1960s. In fact it was the only place in the world to pay attention to this form of art with any consistency. In 1984 and 1987 Panhuysen organized *Echo — The Images of Sound*, a sound art festival in two editions. These were documented in publications, the second in a book and on CD.

Over the years Het Apollohuis published a considerable number of catalogs, books, LPs and CDs. Notable among these are Tom Johnson's sizable book *The Voice of New Music* (now sadly out of print), a collection of articles for The Village Voice in which he chronicled the development of new music in America between 1972 and 1982; Akio Suzuki's CD package *Soundsphere* (also out of print); Doug Quin's CD of nature sound recordings and music based on them, *Oropendola*; Paul DeMarinis' CD *The Edison Effect*, on which he documents explorations into the workings of equipment for sound recording and playing. On the Apollo Records label Panhuysen also released results of his own ventures into the intermediate ground between art and music — in solo projects, with the Maciunas Ensemble and with the Kanary Grand Band (birds living in an aviary on the second floor of Het Apollohuis). In three books Het Apollohuis has documented its activities from 1980 until 1995. Next year it will publish a book covering the last two years of its existence as a venue.

As a place Het Apollohuis still exists, as Paul and his wife Hélène are owners of the building. Some of the activities will not cease, such as publications and residencies. As a curator and adviser for art venues and events Paul has always drawn on his comprehensive network of artists and on the archive of documentation he has built up — and he will continue doing that work.

Het Apollohuis hosted numerous innovative musicians and artists working in the area covered by this magazine. The list is too long to reproduce here; I want to refer those who are interested to the books in which the venue documented its activities.

Because of the regrettable decision of the Dutch Ministry of Cultural Affairs the art world has lost a unique space that never ceased to be innovative, that never compromised its artistic integrity. The Dutch audience are denied the possibility to keep abreast of developments in new music and experimental art. Artists and musicians are denied another possibility to present the results of the more exploratory aspects of their work to a live audience, and get feedback. These were functions that Het Apollohuis was especially well suited for. It was one of those extremely rare places where the experience of art could be personal, because of the opportunity for members of the audience and artists to engage in conversation. Obviously, within the scope of official Dutch art policy there is no room for this.

— René van Peer

The following Apollohuis releases are still available:

Terry Fox — Berlino/Rallentando AR 088807 (vinyl LP)

Paul Panhuysen — Engines in Power and Love ACD 019210

Maciunas Ensemble — Number Made Audible ACD 039211

Paul Panhuysen and the Kanary Grand Band — Singing the World into Existence ACD 039212

Douglas Quin — Oropendola, Music by and from birds ACD 049413

Paul DeMarinis — The Edison Effect ACD 039514

Maciunas Ensemble and Kanary Grand Band — Live with the Birds ACD 129615

Apollohuis documentation books

Het Apollohuis 1980 - 1985 (140 pages) ISBN 90 71638 01 4

Het Apollohuis 1985 - 1990 (144 pages) ISBN 90 71638 12 X

Het Apollohuis 1990 - 1995 (154 pages) ISBN 90 71638 22 7

Distribution in the USA: Forced Exposure, Waltham; Anomalous Records, Seattle; NonSequitur, Albuquerque. In Canada: Verge Music Distribution, Peterborough; Art Metropole, Toronto.

Het Apollohuis, Tongelresestraat 81, 5613 DB Eindhoven, The Netherlands; phone/fax +31 40 2440393

In *EMI*'s last issue (June, 1997), we printed Glenn Engstrand's call for submissions of sound samples for use in a virtual orchestra to be created as part of a forthcoming CD ROM. Unfortunately, we printed an incorrect address. The correct address to which submissions should be sent is 3810 Maybelle Av., #7, Oakland, CA 94619. For more details on this rather intriguing project, you can contact Glenn at that above address, or review the description on p. 4 of *EMI*'s June issue, or visit the web site

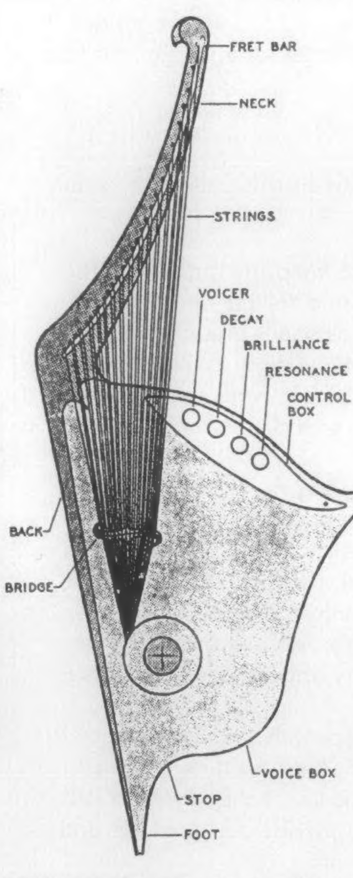
mentioned below. Glenn writes:

Please notify your readership of the error in the next edition of *EMI*. My call for submissions is a sincere one. So much, in fact, that I am willing to delay deadline until April 1,1998 just to give your readers time to respond. For a small-scale example of an *EMI* orchestra pit, point your browser to my personal web site at http://www.sirius.com/~touchles/poetry.htm. Then click on the link entitled "Imaginary Ensemble." If you have a slow connection to the Internet, then the musical instruments will appear to be sluggish. This will not be a problem in the Web CD version since even the slowest CD-ROM drive access time is much faster than almost any network connection.

A NEW ORGANIZATION FOR JEW'S HARP ENTHUSIASTS: You can join The Jew's Harp Guild, and get its quarterly newsletter, *The Pluck-n-Post*, for $10/year. For information contact executive director Janet Gohring at PO Box 92, Sumpter, OR 97877, or visit their web site at http://www.cyberhighway.net/~mposs1/jhghp.html.

Randy Moeller (email randym@eskimo.com) sends this query:

Could you please tell me whether you know of anyone who has actually built the "Vulcan lyrette," which is featured in an episode of the original "Star Trek" and whose schematic appears in the "Star Fleet Technical Manual"? [See the drawing reproduced on the right. For decades, I've been curious to know what the Vulcan lyrette would actually sound like (I assume Spock's performance was dubbed).



The Vulcan Lyrette, as depicted in Franz Joseph's *Star Fleet Technical Manual* (New York: Ballantine Books, 1975). Randy Moeller asks, has anyone ever actually built this instrument?

END OF THE MANDOCRUCIAN: Mandocrucian's Digest, the mandolin magazine produced for the last eleven years by *EMI* contributor Niles Hokkanen, has published its last issue. Niles is a man of wide-ranging and occasionally quirky interests, and this was reflected in the pages of the informative and always colorful (though printed in black and white) magazine. All back issues will remain available from *Mandocrucian's Digest* at PO Box 3585, Winchester, VA 22604.

ANONYMOUS FAMILY REUNION: In the notices section of the last couple of issues, we have been running a notice submitted by anonymous proposing an anonymous family reunion — that is, a gathering of people who have at any time chosen to be anonymous, "whether ... because of sex role oppression, possibility of criminal prosecution, rejection of egoism, mysteriousness, obscurity, sense of humor, or whatever." Plans for the reunion have taken shape, and it turns out that many of the planned activities involve unusual musical instruments. Here are sound-related excerpts from an update on the reunion, submitted by anonymous:

The Anonymous Family Reunion is planned for the last weekend in August, '97. Saturday, August 30th, we'll go to Ringing Rocks State Park (near Upper Black Eddy, PA) some time in the afternoon to play the resonant boulders there as a "Volunteers Collective". Be prepared with metal strikers of some sort (hammers are suggested). Sunday, August 31st, we'll go to Bertoia/Sonambient Studios [home of the Sonambient sound sculptures described in EMI Vol. 12 #3] to witness & record a performance of a play entitled "Momma MIA" written & performed by anonymous (of course). It includes recording natural sounds and metallic sounds within the Sonambient Theater. This'll be followed by shifts of 12 "Volunteers Collective" players each playing their own instruments + the Sonambient sound sculptures. These sound sculptures mainly consist of clusters of tall metal rods & pillow gongs. Players are encouraged to bring instruments & recording equipment of various types (video cameras, 4 tracks, walkmans, DATs, etc..). It's hoped that the recordings from both days will be edited to 1 or 2 90-minute tapes & published by Widémouth Tapes.

For contact information and other details, see the announcement in this issue's notices section.

UNWANTED PYROPHONICS IN INDUSTRIAL APPLICATIONS: The subject of pyrophones has come up frequently in past issues of *Experimental Musical Instruments*, most notably in a selection of articles appearing in our Volume 10 #1 issue, Sept. 1994. Pyrophones are sound devices in which a gas flame is inserted part way into an upright, open-ended glass or metal tube. Under the right circumstances, this will cause a standing wave to be set up within the tube. The effect can be refined to create an organ-like instrument of controlled pitch with many tubes of varying length. Alternatively, the wilder and less predictable qualities of the phenomenon can be used for more dramatic effects. In a recent communication with *EMI*, Gerard Westendorp mentions that a related effect can arise, unintended and unwanted, in industrial applications. "I am especially interested in pyrophones," he writes, "because I am working on the prevention of combustion oscillations in small gas boilers. They can give spectacular sounds, frequencies from 9 Hz to 800 Hz, and extremely loud. It is nice to know than the effect can also be used in art, aside from being a problem for manufacturers."

TOOLS FOR URBAN ORCHESTRAS: Keith Spears recently sent along the following notes on and photo of some industrial

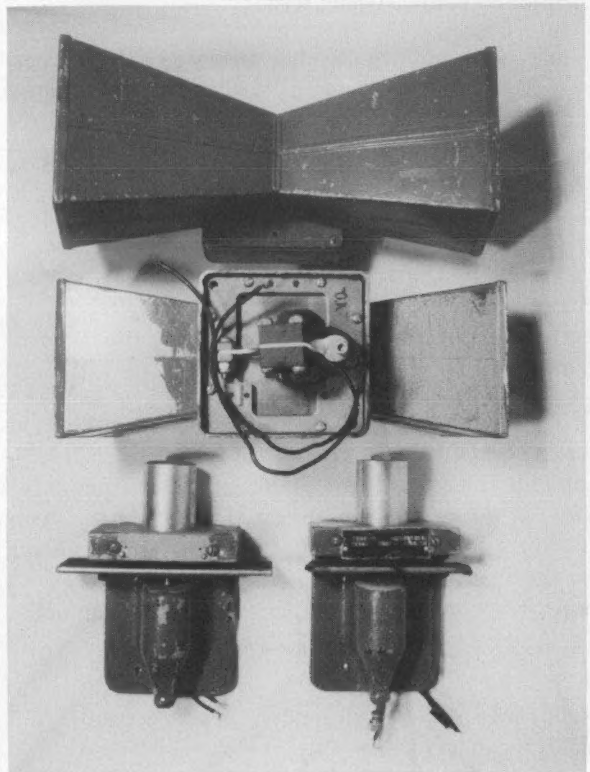
sound-makers he managed to lay his hands on.

Found materials often dictate the creative thought process, so it was a real treasure of a find when I came across two different sets of institutional fire alarms at a surplus auction. With the abundance of alarms in each set, each alarm could be tuned differently to represent a wide scale of notes.

One set of the fire alarms are considered buzzers. They emit a constant buzzing-like sound for as long as A.C. electricity is applied. The actual buzzing sound comes from an electric coil located on the back of the unit which vibrates against a metal diaphragm. The coil is mounted on an adjustable chassis with an allen bolt. Adjusting the allen bolt inward brings the coil closer to the diaphragm causing more of a vibration and thus a higher pitched note. Rotating the allen bolt outwards moves the coil away from the diaphragm causing less vibration and brings forth a lower pitched note. The resulting buzz sound is sent through a megaphone-like structure for amplification.

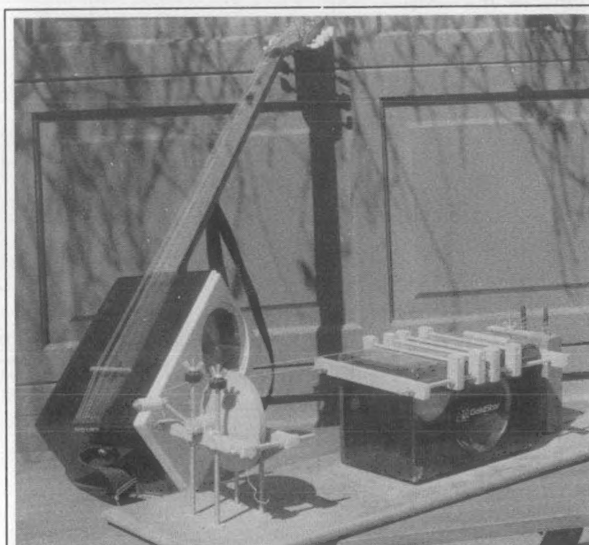
The chimes are much different than the buzzers. They are essentially an electric xylophone. When electricity is applied, a coil is energized with a magnetic field which in turn causes a metal pin to jolt upwards and hit a piece of bar stock. The bar stock's ringing is amplified by an aluminum resonance chamber located above it. The metal pin is only fired once, and then resets itself. The electrical current must be stopped, and then applied again for another ringing action.

To tune the chimes, the bar stock's length would have to be cut to varying sizes. The surface of the bar can also be modified with a grinder, running grooves into it. This would alter the overall tone, or timbre, to make the sound more unique and your own.



Above: Industrial chimes & buzzers, salvaged by Keith Spears

Below: Humidifier tank instruments by Ben Cohen



Ben Cohen has sent along the photo at right of instruments built from ultrasonic humidifier tanks. He writes:

Living in a dry climate, I rely on humidifiers to keep my many wooden musical instruments from becoming unglued and falling apart on me. While my lutes stay healthy, the humidifiers occasionally break down. I've discovered that the water tanks from broken humidifiers make excellent resonators for stringed instruments. The hard plastic walls work well as sound boards, and the tanks come with built-in sound holes and carrying handles.

The picture shows a hurdy-gurdy and a long-neck plucked string instrument built around humidifier tank resonators. The hurdy-gurdy uses an adjustable mounting system (lots of bolts) which allows the wheel and strings to be set up at the optimal heights and angles for "bowing." It also features a primitive but surprisingly successful adjustable fretting system. I built it to accompany a group of friends who needed a drone instrument for performing medieval chants of 12th century abbess Hildegaard Von Bingen.

The plucked string instrument has a long neck with 4 double strings. I originally intended it to be an octave mandolin, but now tune it in a pair of open fifths (G D g d). With its drone strings and low, flat bridge it sounds like a middle eastern saz. The humidifier tanks provide a bright tone and plenty of volume for their size on both instruments.

Dave Knott sends this unusual and intriguingly simple idea for getting exotic sounds from a loudspeaker:

Recently, I was collecting material for a found sound board installation when I encountered energy becoming music.

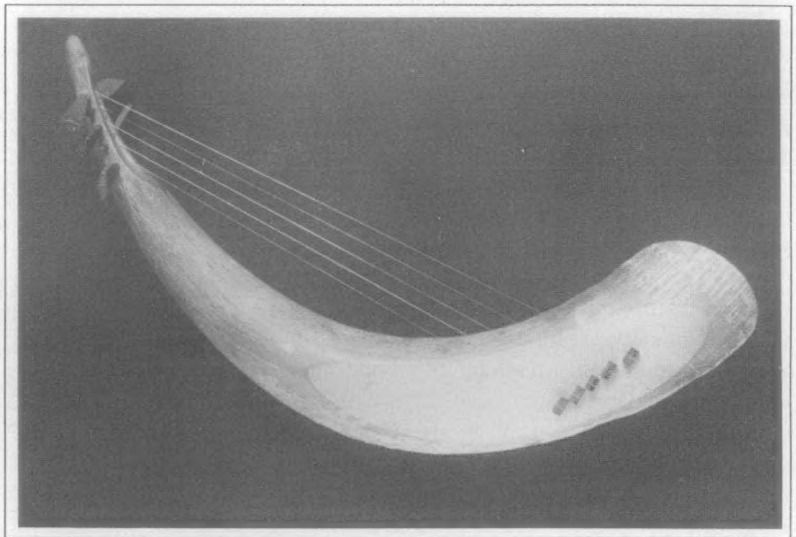
I took a 1.5 volt AA battery and hooked it up to a speaker. When I scratched the lead wire against the battery, the speaker crackled and snarled in rumbling belchy tones. This occupied my full attention for about an hour or so ... visions of chamber suites for five batteries and five speakers translating some scorched telling of the source of light; life.

So I started thinking about sticking a string in the circuit. I used one of my smaller soundboards and attached one of the speaker wires to a string. The other wire I taped to the positive side of the battery. While bowing the string, I used the negative side of the battery to "fret" or touch the string at various points. The resultant sound was exquisitely beautiful. After some effort, I was able to play simple melodies using the

negative side of the battery as a slide.

My understanding of how this works is that the battery simply makes the cone of the speaker move. It is either forward (with current applied) or back (no current.) So the scratchy sound is the cone moving back and forth at a relatively slow, irregular frequency. By adding the string, one is able to make this back-and-forth/on-and-off pattern happen more frequently. So, just as an *A* string produces an acoustic tone by moving air at 440 vibrations per second, so an *A* is produced through the speaker by making this connection at 440 vibrations per second.

Initial tests yielded similar results but it seems that there is much room for development and experimentation. For instance, by substituting the speaker with an output jack, the metaphone could be used amplified or as a dynamic midi trigger.



Horn Harp, by Sam Pappas, 1982. Part of the coming Shapes of Sound Exhibit, Woodland Pattern Book Center, Milwaukee.

Needed for construction:

one taut string (a simple wall harp with two screws and a wire or a guitar will do)

1.5 volt AA battery (recommended, for less current through the body. For safety, *do not* use any sort of high-voltage battery.)

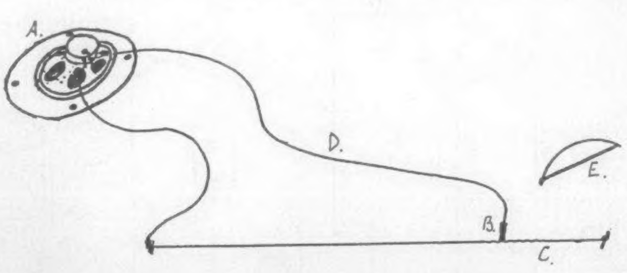
2 speaker wires

tape, electrical

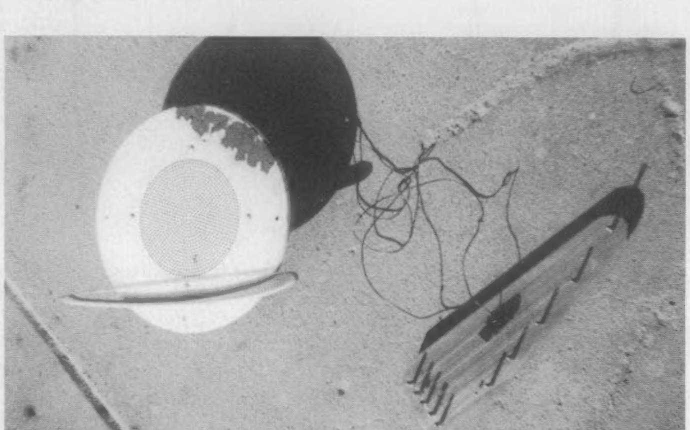
old speaker

Connect the two speaker wires to the speaker. Connect one wire to a string. Best connected near an end, such as on an electric guitar's bridge, or near the end of the string on an acoustic device. This minimizes interference in the movement of the string. The other wire should be taped to the positive side of the battery. Use the negative side to lightly touch the string. Now bow. It is important to only lightly touch the string with the battery as it is the vibration against the terminal that causes the pitch. If the battery terminal is depressed hard against the string, no vibration will occur and no tone will be produced. By moving the battery along the string, different pitches are produced.

Alternately, a wire lead may be attached to the negative side of the battery and put against the vibrating string. Also, different metallic pieces may be attached to the end of this lead for different effect.



Above and below: The Metaphone, by Dave Knott.
Components in the diagram above: A. Speaker. B. Battery. C. String. D. Electrical wire. E. Bow.



THE HORN HARP pictured above was designed and built by Sam Pappas in 1982, one among many string and percussion instruments created by Sam Pappas in Chicago between 1979 and 1987. During these years Sam Pappas led the new instrument ensemble "Tumbling Strains" (its name inspired by Curt Sachs' *The Wellsprings of Music*) that featured members of several active improvising ensembles including Liof Munimula (Michael Zerand and Don Meckley) and Clamdance. "Tumbling Strains" played improvised music inspired by ambiguous, found titles, such as "Rain of Terror," a performance that included one of Don Meckley's electroacoustic water-drip instruments, the hydro-kalimba. Sam Pappas approached instrument building from a visual perspective, frequently prompted by readily available materials and found objects, but his instruments and musical outlook have always been organic and spiritual ("not cold" as Sam Pappas emphasizes) and always with an eye for organic form.

Musical Instruments by Sam Pappas will be part of an exhibition SHAPES OF SOUND featured at Woodland Pattern Book Center and Gallery in Milwaukee, Wisconsin from October 12 through January of 1998. This exhibit of midwestern instrument inventors curated by Hal Rammel will include among others Bill Close, Michael Meadows, Liz Was and Miekel And, Eric Leonardson, and David Lundahl. Woodland Pattern is located at 720 East Locust in Milwaukee. Call 414/263-5001 for further information.

EMI NO LONGER TO BE AVAILABLE AT MOST NEWSSTANDS

After this issue, *Experimental Musical Instruments* will no longer be available at most newsstands. So, please! If you've been picking up your copy of each issue at a newsstand, subscribe now, so we don't lose you!

EMI will continue to appear at certain independent retail outlets that have long carried us, as well as those news outlets served by the Tower distribution network.

The reason for this change is simply that newsstand distribution is not economical for us. Magazines that derive most of their income from advertising benefit from newsstand sales even when the sales are actually made at a loss, because larger readership numbers translate to increased advertising revenue. This logic doesn't apply to *EMI* because advertising represents only a tiny part of our income. (We don't carry many ads, and most of those that we do carry represent exchanges, not sales.)

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(Overseas subscriptions, as opposed to orders of other items, are all sent by air, with shipping costs being built into the overseas subscription price.)

WEB SITES OF INTEREST

The following is a short list of sites on the World Wide Web relating to unusual musical instruments that have come to *EMI*'s attention recently. Many more are listed in previous issues of *EMI*.

The number of web sites devoted to musical instruments, like web sites in all other areas, has increased exponentially in recent months. Listings such as this one become increasingly inadequate in representing both the wealth and the rapidly expanding pile of garbage that make up the web today. The search engines that allow you to seek out information relating to specific topics can be extremely helpful in making sense of it all. It's worthwhile to learn to use the search engines skillfully to carefully delineate one's searches.

Pigeon Flutes and Whistles from China (small flutes of bamboo or gourd attached to pigeons, to sound as they fly): http://www.ci.walnut-creek.us/pigeonflutes.html

Kite Musical Instruments: http://members.aol.com/woinem1/index

Ondes Martenot (an early electronic instrument): http://www.vuse.vanderbilt.edu/~jbbarile/ondes/OndesPres_1.htm

The theremin homepage (there are many sites devoted to theremin; this one is admirably thorough, and has extensive links to others): http://www.Nashville.Net/~theremin/

Theremin teacher's registry: http://www.ccsi.com/~bobs/theremin.html

The Jew's Harp Guild: http://www.cyberhighway.net/~mposs1/jhghp.html

Bob Grawi's Gravikord: http://members.aol.com/gravikord

Uillean Pipes (this site links to a site giving instructions for pipe construction): http://www-bprc.mps.ohio-state.edu/~bdaye/pc_intro.html

Starrboard and other Instruments by John Starret: http://www-math.cudenver.edu/~jstarret/instruments.html

Richard Waters' waterphone: http://spacebeat.com/waterphone/

Cylinder recording: http://www.tinfoil.com

Glenn Engstrand's site, including his virtual orchestra: http://www.sirius.com/~touchles/poetry.htm

A new site devoted to Harry Partch: http://205.216.138.19/~websites/jszanto/welcome.html

Software for retuning synthesizers to any scale: http://www.justonic.com

New e-mail list devoted to unusual musical instruments: *oddmus*. To subscribe go to the Coollist Main Page at http://www.coollist.com/.

... and a correction from last issue's listings: We gave an incorrect address for the web site of *The Improvisor*. The correct address is http://www.nwrain.com/~rotcod/improv.htm

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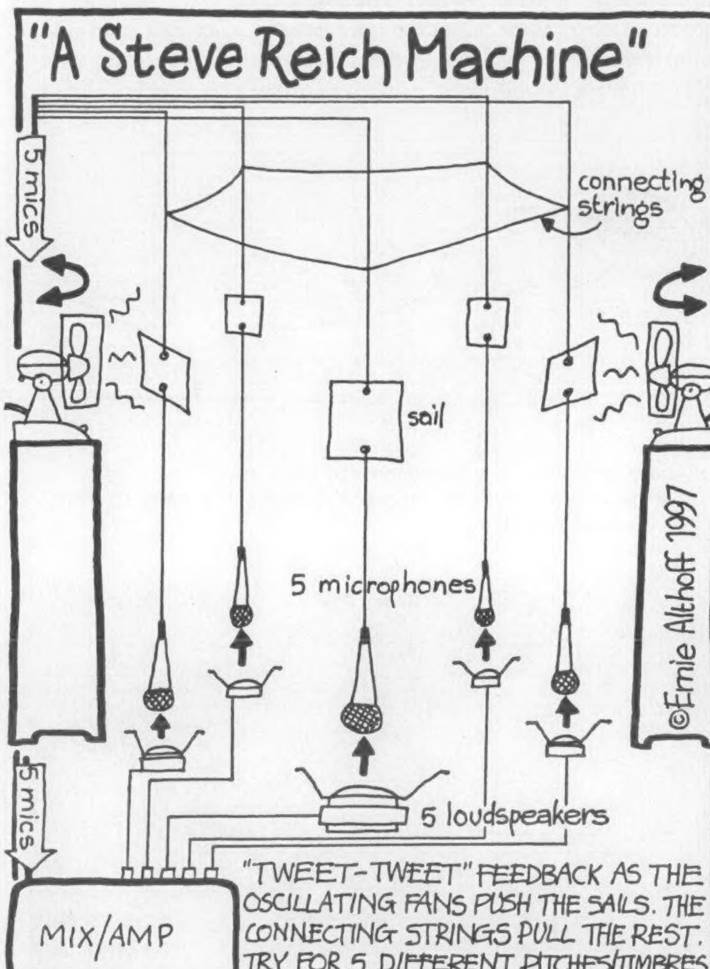
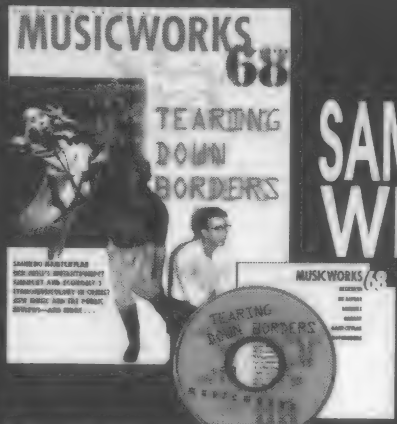
Below: Another in a series of possible instruments conceived and drawn by Ernie Althoff



MUSICWORKS

EXPLORATIONS IN SOUND

An internationally respected arts journal that explores new and possible musics, multi-media, performance art, and sound ecology.



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VISIT OUR WEB SITE:
www.jtfree.com/penumbra8/index.html

OR WRITE:
PO BOX 282, GRAFTON, WI 53024 USA

This is the first of two articles on speech synthesis by Martin Riches. In this first one, Martin provides a basic grounding in the mechanics of speech production, and then describes four important historical synthetic speech devices. The second article, which will appear in the coming issue of *Experimental Musical Instruments*, is devoted to the mechanical speech synthesizer that he himself has been building, called The Talking Machine.

SPEECH PRODUCTION AND FOUR HISTORICAL SPEECH SYNTHESIS PROJECTS

By Martin Riches

What is speech synthesis? Well, a very short definition might be: Speech synthesis is the art of producing what sounds like the human voice but without using any form of recording.

Intelligible electronic speech synthesis first became possible in the late 1930s but the art of producing speech artificially is much older than that. Long before the first experiments in electronic speech synthesis, there were several successful attempts to reproduce the sound of the human voice using the techniques of the organ builder and instrument maker.

I will describe four historical projects which I read about while preparing to make a talking machine of my own; four projects where I found informative and credible drawings and texts. But first, since talking machines are analogs of the human speech apparatus, I shall first give some brief workman-like notes on acoustic theory and on the human production of English speech sounds.

ACOUSTICS

The human vocal tract is a tube about 17 cm. long, open at the lips and effectively closed at the other end at the vocal chords. If you take a piece of cylindrical tubing of this length, fit it with a reed in place of the vocal chords and blow it, you will get a strong resonance around 500 cycles per second with further peaks of strong resonance odd-number multiples of 500 — at 1500, 2500, 3500, 5500 cycles per second and so on. In fact, the insides of the mouth and throat do not form a perfect cylinder and, what is more, the hollow shape is constantly changing as we talk. As a result, these resonance peaks are shifted around away from that original regular pattern. These strongly resonant frequencies give the various speech sounds their individual character. Just three, or even two, of the lower peaks are all we need to identify a speech sound. These peaks of strongly resonant frequencies are referred to in the speech synthesis field as "formants." The formants are also influenced by the continuously changing timbre of the vocal chords. If a frequency is absent from the original sound it will be absent from the final speech sound. However this effect is of secondary importance as far as speech production and recognition is concerned.

HOW TO SPEAK ENGLISH[1]

The human vocal apparatus consists of:

— an air supply, the lungs;

— an adjustable resonator, the mouth, containing a lump of flexible muscle of constant volume but variable shape, the tongue. The volume of the mouth cavity can be increased by lowering the jaw. This adjustable resonator is about 17 cm long and the cross-section can be varied from zero to about 20 sq.cm.

— a non-adjustable resonator: the nose, joined to the mouth by a flap valve. It has a capacity of about 60 cc.

— four noise-making devices: the vocal chords, tongue, teeth and lips.[2]

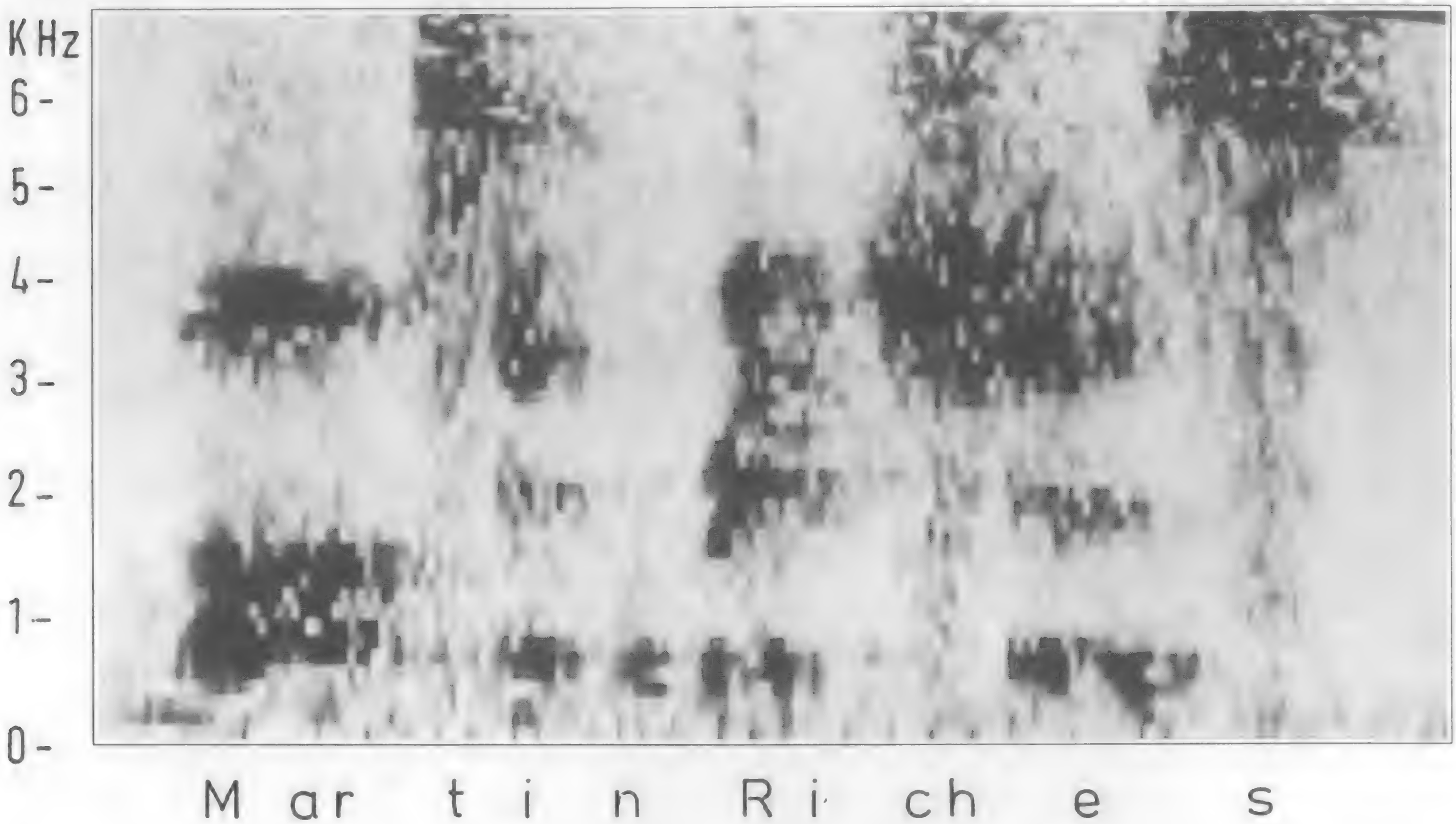
The name "vocal chords" is misleading; it seems to suggest that the voice is a string instrument. In fact it is more like a trumpet. The vocal chords are two strips of soft flesh — two internal lips — which form a constriction in the pipe leading up from the lungs. This constriction can be opened and closed at will. When it is open we breath freely. When the vocal chords are partly closed, the air passes through the constriction causing the vocal chords to vibrate making a farting noise — like the sound you can make by blowing between your closed fingers or the sound that trumpeters make with their lips. Like a trumpet player's lips, the tension of the vocal chords can be increased to raise the pitch.[3]

1. Languages vary; English has neither the click sounds of Xhosa and !Kung nor the nasal vowels of French.

2. But perfectly intelligible British English can be spoken while clenching a pipe between the teeth and not moving the jaws at all.

3. Men generally have lower pitched voices than women and children because their vocal chords are longer. The vocal chords have other functions. When you are about to lift a heavy weight you inflate your lungs and close the vocal chords to "hold your breath". This is braces the rib cage and helps transfer the load from the arms and shoulders to the spine and stomach muscles. The vocal chords also provide a last line of defense below the epiglottis to prevent food "going down the wrong way" into the lungs.

Fig. 1. Spectrogram of the author's voice speaking his name. Note the three bursts of high frequency sound for the T, CH, and S sounds. The short horizontal bands for the AR, I and E sounds represent the formants of these sounds. The spectrogram was produced by Dipl. Ing. Klaus Hobohm of the Technical University, Berlin.



The vocal chords, slapping together about 50 times a second, produce a sound which is rich in overtones. To demonstrate how this sound is adapted by the mouth resonator to produce speech sounds, try the following experiment. Simulate the mouth cavity by forming an enclosed space between your two hands and then blow into it with a farting sound. Continue blowing while changing the shape of the cavity and open and close some fingers to simulate the lips. You should be able to make some convincing OO-AH vowel sounds and some semi-vowel sounds like WAH WAH.[4]

As you can hear, there is no essential difference between the production of vowels and the production of voiced consonants like *W*. The voiced consonants are just performed with the tongue moving faster. *L* and *R* sounds are produced by flapping movements of the tongue originating from two different points on the roof of the mouth.[5] *K* and *G* sounds are made by the tongue touching the roof of the mouth further back from the *L* and *R* positions and momentarily blocking and then releasing the air supply. The *K* sound is produced without the vocal chords vibrating.

If the mouth is closed or the mouth cavity is blocked off by the tongue and, at the same time, the flap valve leading to the nose is opened, humming "nasal" sounds are produced. The three English nasal sounds, *M, N* and *NG*, are distinguished according

4. Sir Richard Paget used a similar technique, blowing a rubber reed, held between his thumbs, which enabled him to "talk with his hands". See bibliography.

5. Japanese and Chinese have a sound where the tongue starts from a point exactly between the English *L* and *R* positions. They often use this convenient central position for both *L* and *R* when speaking English. Thus, for English-speaking listeners, their *L*s may sound like *R*s and their *R*s like *L*s.

Fig. 2: Sections through the vocal tract, pronouncing various vowels. Redrawn from: Gunnar Fant, *Acoustic Theory of speech production*. 's-Gravenhage, Mouton & Co, 1960.

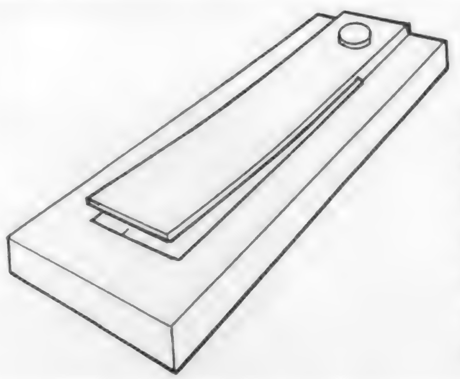


Fig. 3: A free reed. The reed is just small enough to swing through the opening in the plate, rather than beating against it, thus producing a less harsh sound.

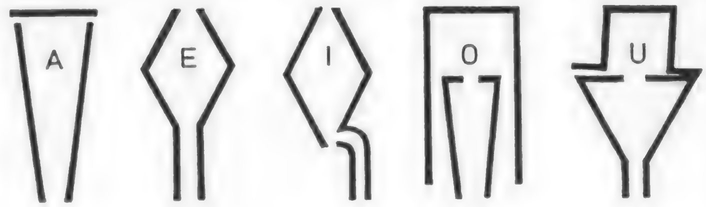


Fig. 4: Kratzenstein's vowel resonators. (Redrawn from from: James L. Flanagan, "The Synthesis of Speech" in *Scientific American*. Vol. 226, No. 2, pp 48-58, February, 1972.

to the position of the tongue. An *M* is a humming sound with all the sound coming out of the nose. Try it. The tongue is low. Now move your tongue up, blocking off the front of the mouth behind your front teeth, and it changes to an *N* sound. Since you have blocked off the front of your mouth it makes no difference to your *N* sound whether you now have your lips open or closed. Now move your tongue further back and you get an *NG* sound. Hold your nose and the sound stops. If you say "I siNG a soNG to the MaN iN the MooN" while holding your nose, you will hear that it is only the nasal sounds which get distorted.

As we have seen with *K*, some sounds are produced without using the vocal chords. If you speak while touching your Adam's apple (the outer casing of the vocal chords), you will feel that most of the time they are vibrating. But they can open and allow the air to pass freely to the front of the mouth to produce the "unvoiced" hissing sounds: *S*, *SH*, *TH*, *F* and *T*, the fricatives. These sounds are produced by the teeth working in combination with the tip of the tongue and lips to form whistles with different resonators formed by the lips. *T* is just a short explosive *S*. Sounds such *V* and *J* (as in JuDGe) are produced like *F* and *SH* but with the vocal chords "switched on". The *H* sound is produced by producing a hiss in the half-closed throat.

The lips have two functions. They modify the vowel sounds — compare the position of the lips when you say AH, EE and OO. The lips can also be closed, retaining a supply of compressed air which is released to produce the explosive *P* and *B* sounds. *B* is pronounced with the vocal chords vibrating; *P* is just the sound of the released air. (The explosive sounds *P-B*, *K-G*, *T-D* are known as "plosives" or "stops").

None of these speech sounds are absolute. Speech is a continuous process: sliding from one speech sound to the next one. Since the tongue and other speech organs have an appreciable mass, it takes a little time to shift them into the correct position, so that each sound is influenced by the sound that came before and anticipates the next sound to come.

Furthermore, everyone speaks differently: even the short telephone message "Hi! It's me!" is sufficient to identify someone whom you have heard a few times before. Because there is such a wide variety of speech, we are highly skilled at recognizing the underlying patterns — but we also rely very heavily on context. Provided that the listener has some idea of what to expect, it is possible that even a comparatively simple device which can reproduce human speech sounds at the correct tempo, will be understood.

FOUR HISTORICAL SPEECH SYNTHESIS PROJECTS

1. Kratzenstein

In 1779, the Imperial Academy of St. Petersburg, for its annual scientific competition, offered a prize for an answer to the following two questions:

1. What is the nature and character of the sounds of the vowels *a*, *e*, *i*, *o*, *u* that make them so different from each other?

2. Can an instrument be constructed, like the vox humana pipes of an organ, which shall accurately express the sounds of the vowels?

The prize was won, two years later, in 1781, by Professor Christian Gottlieb Kratzenstein, a German living in Copenhagen, who constructed a set of acoustic resonators to speak the vowel sounds. To produce the sound of the vocal chords Kratzenstein used a "free reed", the type of organ reed which was later used in the mouth-organ, the accordion and similar instruments. Apparently he invented it for this purpose.

On top of the reed Kratzenstein placed a resonator — a wooden box — an analog of the inside of a human mouth. This box adapted the sound of the reed just as a real mouth adapts the sound of the vocal chords. The shape of the resonator was different for each vowel. Looking at the sections of Kratzenstein's pipes it seems probable that they were designed on a trial-and-error basis without trying to precisely imitate the mouth positions. Evidently a wide variety of shapes will produce recognizable vowel sounds.[6]

2. Von Kempelen

It was a contemporary of Kratzenstein who is generally acclaimed as the Father of Speech Synthesis. In 1791, after some 20 years of research Wolfgang von Kempelen published "The mechanism of human speech, together with a description of a Speaking Machine". Von Kempelen's Speaking Machine not only successfully imitated the vowels and many of the consonants but was also able to speak complete words and phrases. Air was supplied by pumping a bellows. The mouth was simulated by a flexible rubber resonator. Kempelen's left hand manipulated this mouth, while his right hand controlled the ivory "vocal chords," opened the "nose" tubes to provide *M* and *N* sounds and pressed

6. There is a superb modern version of Kratzenstein's vowel resonators at the Exploratorium in San Francisco called "Vocal Vowels". It was designed and built by Stephen Green using modern data derived from X-rays of the vocal tract.

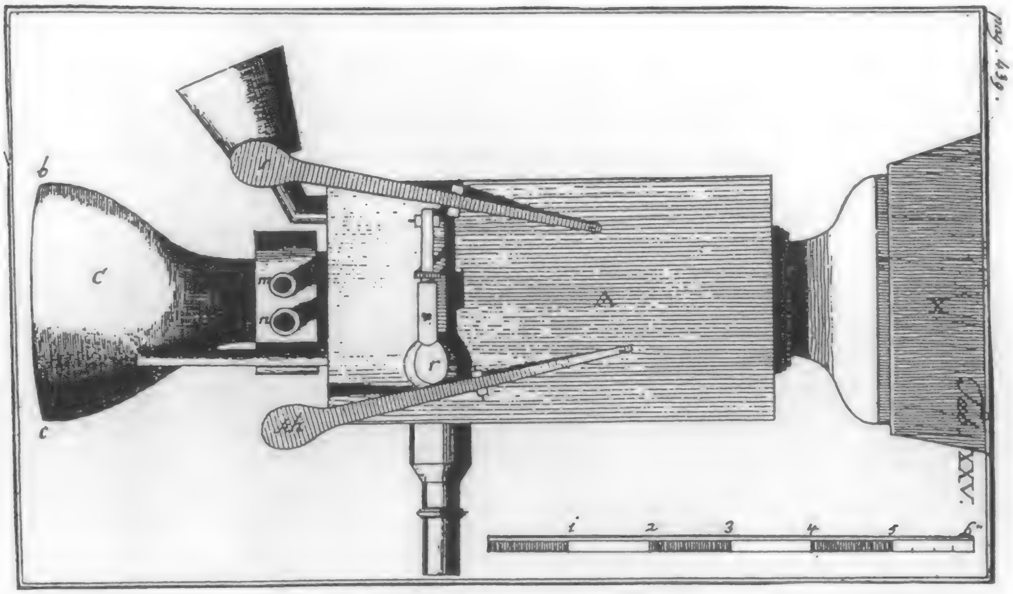


Fig. 5: Von Kempelen's Sprechende Maschine. (From: Wolfgang von Kempelen, *The mechanism of human speech together with a description of a speaking machine*. Wien: Degen 1791.)

A. Box containing an ivory reed.

Manipulated by left hand:

b-c — mouth.
C — rubber resonator.
Underneath C — a small auxiliary bellows, not visible. Operated by right elbow:
X — Part of the bellows, about 16" long.

Operated by fingers of right hand:

S — S key. Under it, the S pipe
Sch — Sh key. Next to it, the Sh pipe
m, n — Nostrils, normally closed by fingers
r — Reed key. When depressed it stops the reed vibrating.

The scale is in inches.

keys to play the *T*, *S* and *SH* sounds.

At the time people were a little suspicious that there might be a trick involved — and not without reason. Kempelen had previously caused a sensation with his amazing chess-playing automaton. It turned out that the chess playing mechanism was operated by a legless and therefore easily concealed human chess player hidden inside.[7] However his Speaking Machine was a completely legitimate device and quite well known in its time. Wolfgang von Goethe commented on it: "Kempelen's Speaking machine ... is not very talkative but it pronounces various childish words and sounds quite nicely..."

One might suspect that Kempelen's Speaking Machine could say little more than "Mama" and "Papa" like a Victorian talking doll; indeed it did have a rather high-pitched and therefore childish voice. But according to von Kempelen's own account it could also say:

Vous etes mon ami — je vous aime de tout mon coeur
Leopoldus Secundus — Romanorum Imperator — Semper Augustus

It was not so good at Kempelen's native German, perhaps because it was difficult to reproduce the staccato quality of the language, the pure vowel sounds and the many stops, with sufficient accuracy. Kempelen sums up his operating instructions as follows:

1. ... the right hand should rest on the wind chest so that the index finger and the middle fingers just cover the *M* and *N* nose holes. The thumb comes over the lever or key *SCH* and the little finger over the S. The left hand covers the opening of the mouth.

2. The right elbow always rests on the bellows. To speak a letter the bellows must be pressed down, sometimes hard, sometimes softly. This pressure has to continue until the word which is being spoken is finished otherwise the letters and syllables will not join together with each other. If one lifts the elbow, the voice is silent.

3. The nose must remain closed for all letters, except *M* and *N*.

4. For all unvoiced consonants and wind consonants the mouth must remain shut.

5. For all wind- and voice-consonants, the mouth should not be completely closed but kept open enough to allow the voice to sound as well.

(Trans.: M.R.)

He then goes through the alphabet describing how to speak each letter.

Although his description of speech as "voice passing through restrictions" may be seen as a mechanistic interpretation of the filtering effects of resonance he did not understand the fundamental acoustic processes taking place. Nevertheless his practical approach was sufficient to produce a machine which really did work. Perhaps his greatest achievement was his book "The Mechanism of Human Speech (..)" which is extremely readable, well illustrated and has the reputation of being one of the finest physiological books of its time.

3. FABER'S EUPHONIA

Professor Joseph Faber produced Euphonia in 1830 (or 1835) and it took 25 years to build. The "facade" was the head of a young woman mounted on a machine draped with women's clothes. A second version, Euphonis, took the form of a bearded Turk. The machine was played by 16 keys connected by wires to the rubber speech components, similar to the organs of a human being. Air came from a double bellows. It could recite the alphabet, and could say "How do you do, Ladies and Gentlemen?" It asked and answered questions, whispered, laughed and sang. Since it was built by a German speaker it spoke English with a German accent. There follows a rather patronizing description by a professor of the faculty of medicine, Paris.

Machine Parlante de M.Faber par M.Gariel

Monsieur Faber has set out to construct a machine which really talks, that is to say produces the sounds and articulations and to arrive at this result he has imitated, at least in a general way, the organs of phonation.

---

7. Further evidence of Kempelen's genius: having met a legless master chess player he conceived a splendid way of employing him.

The machine is composed essentially of three parts:

1. the bellows
2. the sound-producing device
3. the articulating device

1. We do not have anything particular to say about the bellows which is intended to send a current of air to the larynx.

2. The device which produces the sound, the larynx, is a reed made of ivory, the length of which can be varied, within certain limits, so as to change the pitch of the sound it produces. It is regrettable that Monsieur Faber did not attempt to use a system of membranous reeds[8] which would have had the advantage of bringing the machine closer to reality.

3. The articulatory device consists of a part which produces the vowels and a part for the consonants. The vowels are produced by the passage of air through openings of various shapes cut in partitions which are successively placed in the path of the current of air by the operation of levers driven by the keys; furthermore there is a special cavity which can be connected to the previous one which is intended to produce the nasal sounds, the connection being made at will by means of a special lever. The consonants are produced by parts which function in a very similar way to the lips, the teeth and the tongue. A special rotor produces the roll of the *R*. All these parts and organs are set in motion by fourteen keys which are most ingeniously laid out so they can drive the organs with suitable intensity and in the correct order to produce a syllable. Fourteen keys suffice because, with the assistance of auxiliary keys the character of a consonant can be changed from unvoiced to voiced, etc.

The voice of the machine is, of necessity, monotonous and, it must be added, it is not perfect. Some sounds produce a better effect than others. However, in general one can understand the words and phrases pronounced although one would certainly not think of comparing the sounds it produces with the varied intonations of the human voice. Despite the improvements which need to be made to it, this machine is nevertheless interesting because it clearly shows the mechanism of phonation, which can be reproduced artificially in this way, and which in consequence can be shown to exactly obey the laws of acoustics.

—Journal de Physique, théoretique et appliquée, Paris, 1879, pp 274, 275. (Trans.: M.R.)

Fig. 6a: Faber's Euphonia, from a contemporary poster. (Reproduced in: Alfred Chapuis & Edmond Droz, *Les Automates*, Neuchatel, Éditions du Griffon 1949.) This tantalizing drawing does little to explain how Euphonia actually worked. Part of the mechanism seems to be dedicated to animating the mask. If any reader has more information about Euphonia, perhaps they could share it with us.

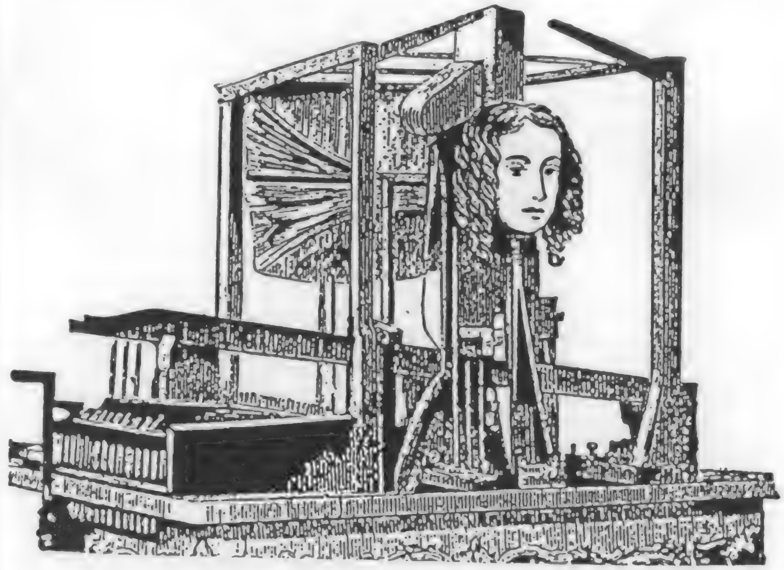
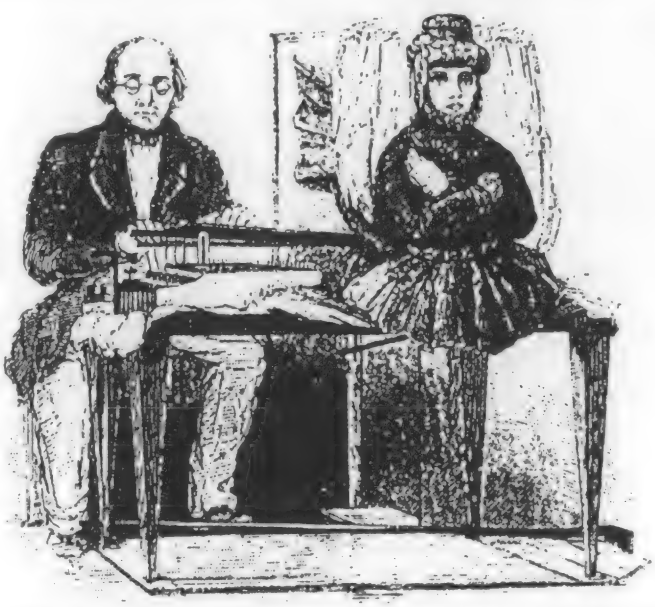


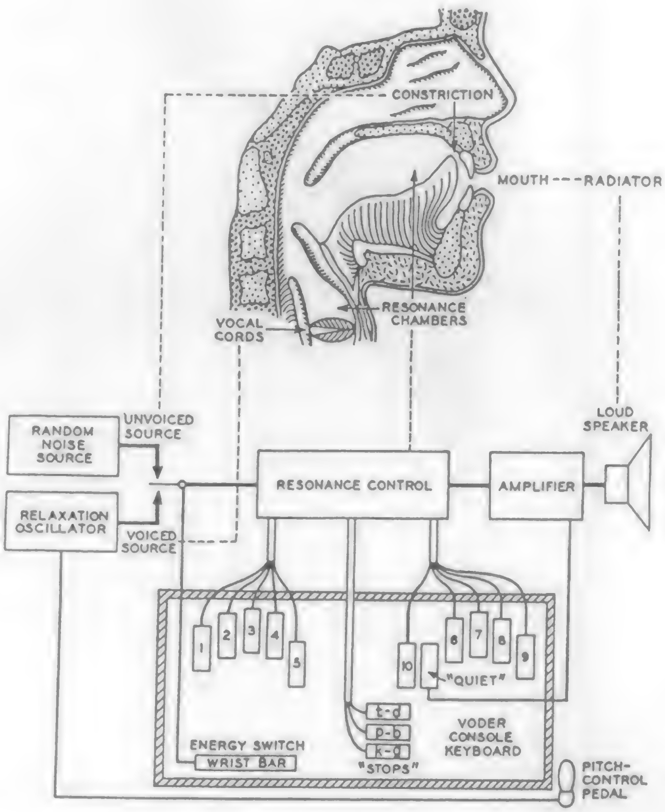
Fig. 6b: Euphonius, Professor Faber at the controls. (Reproduced in: Jasia Reichardt, *Robots. Fact, Fiction & Prediction.* Thames & Hudson, 1978.)



My information about Faber's Euphonia is confused because of conflicting dates which I have not been able to resolve. Professor Joseph Faber was born circa 1800 in Freiburg im Breisgau and it was here that he built Euphonia. He later moved to Vienna. Euphonia was first exhibited in 1840. He traveled with it, showing it at the Egyptian Hall in Piccadilly in 1848. Contemporary reports say that Euphonia was far superior to von Kempelen's machine and anything that came before. However, unlike the self-confident von Kempelen, Faber was a fanatical loner who built his machine under the greatest privations. He never became rich nor was he satisfied with his creation and finally he killed himself. He is said to have destroyed Euphonia in desperation.

Surprisingly we find that shortly before this, in 1853, Phineas Taylor Barnum rented Euphonia for $20,000 for a half year ("an exorbitant price," as he says in his memoirs). He showed it for a time in his American Museum. The picture, circa 1873, shows Euphonia as it was exhibited by Barnum.

8. Fr. *anches membraneuses*, presumably rubber reeds.



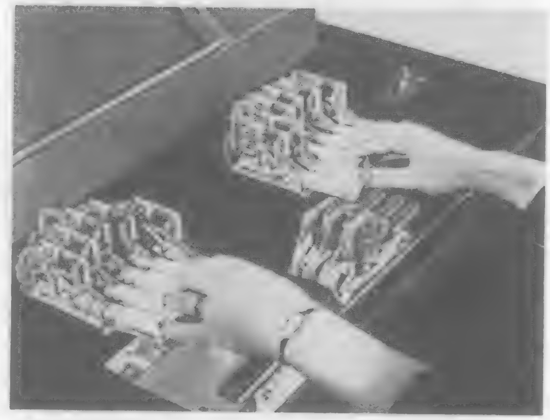


Fig. 7a (above): The essential parts of the Voder.

Fig. 7b (upper and lower right): The Voder and operator.

All from: H. Dudley, R.R. Reisz, S.A.A. Watkins, "A Synthetic Speaker," in *Journal of The Franklin Institute*, Vol. 227, June 1939, No. 6 pp. 739-764.

Chapuis (see bibliography) mentions that in another article (substantially the same as above, in *Magasin pittoresque*) Gariel refers to Faber as an engineer and suggests that perhaps Gariel is referring to Joseph Faber's son and to an improved machine. This would resolve the conflicting dates. If any reader has information about Euphonia's career in America, perhaps he or she can share it with us.

4. The Voder

In the 1920s, experiments began with electronic speech synthesis. Just as in the 18th century, they started off by trying to synthesize vowel sounds and then progressed to complete speech. In the mid 1930s Bell Telephone Laboratories started a major project called the Voder (Voice Operation DEmonstratoR), intended as an exhibit for the World's Fair which was to be held in New York in 1939.

The Voder had ten main keys. Each key, connected to a potentiometer, operated a band-pass filter controlling one section of the sound spectrum up to 7500 cycles per second. A wrist switch changed over from the voiced to the unvoiced sound source. Three additional keys triggered the *T-D*, *P-B* and *K-G* plosives. There was a pedal to regulate the pitch so that the Voder could speak with a natural intonation.

Like von Kempelen's Speaking Machine and Faber's Euphonia, the Voder required considerable skill and manual dexterity to operate it. Bell Telephone adopted a methodical but extravagant approach to the problem of operating the machine which is in marked contrast to the lonely efforts of the pioneers.

Bell Telephone first selected 320 New York Telephone Company and AT&T switchboard operators and put them through an aptitude test: basically, sitting them in front of the keyboard and seeing how they got on making a simple sentence. Thirty of the candidates were selected for the instruction course. After *a year of individual tuition on ten identical machines* they had narrowed the field to a pool of twenty-four girls who could play the Voder keyboard and make it talk almost without thinking about it.[9] They

9. The training period was preceded by intensive study to optimize the controls, to develop a keyboard technique and to decide on the best methods of instruction. Each operator had six half-hour sessions a day, with lessons given every second day. This was found to be about as much as anyone could stand. Various refinements were added to the machines in the course of the training period as a result of experience gained.

worked in shifts operating the machine at the New York World's Fair and later in the Golden Gate Exposition in San Francisco.

The intelligibility of the Bell Telephone Voder was apparently quite good but to make quite sure everyone could understand it they had a narrator with a microphone who would talk with the machine to provide "cues" and so prepare the listeners for what they were about to hear. The performance, constantly repeated in front of a standing audience, lasted five or six minutes.

An annotated bibliography of recommended reference works in the field of speech synthesis will follow the second of Martin Riches' articles, scheduled to appear in the coming issue of Experimental Musical Instruments.

Born on the Isle of Wight, England, in 1942, Martin Riches studied at the Architectural Association in London and practiced architecture until 1978. Since then he has worked exclusively as an artist. Since 1975 he has built a series of machines which emulate fundamental human activities: walking, drawing, writing, talking, and making music; also Sound Sculptures and Sound Installations. His Music Machines have inspired many composers to write for them. He lives and works in Berlin.

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SIRENS Part Two

By Bart Hopkin

This is the second half of a two-part article on Sirens. Part One, which appeared in EMI's last issue (Volume 12 #4, June 1997), discussed what sirens are and how they work, and also delved into the history of siren-like devices — which turns out to be a more diverse and colorful history than one might have expected. In this second part, the author talks about a pair of simple musical sirens that he made, with the idea of passing on some the practical design and construction information picked up along the way.

At the close of the first part of this article, I commented that sirens have only rarely been designed and used as musical instruments. This is despite the fact that many of the intriguing historical sirens that we saw clearly suggested musical possibilities, with the capability to produce musical scales in a controlled and melodic fashion. With this in mind, a few years ago I decided to make a simple siren designed expressly as a musical instrument. Later I built another with a slightly more sophisticated design. In this part of the article I'll describe those instruments and review some of the information gleaned in the process of making them. The instruments were not fancy at all, and they were flawed in many ways, so I'm writing now not to show off my work, but just to pass on a bit of what I learned — humbly hoping to contribute, in this way, to a brighter future for musical sirendom.

The first siren I made is shown in Figure 1. It follows closely the model of the simple single-disk sirens described in Part 1.* To describe its basic elements: The heart of the instrument is a single disk with nine concentric rings of holes. The disk turns on a bearing mounted on a wooden base that can sit on a table top. There's a small electric motor mounted off to one side, with a belt drive to turn the disk. The player sounds the instrument by blowing through a flexible plastic tube of about two feet long. One end of the tube has a nozzle fashioned out of wood which concentrates the air stream. Mounted to the side on the base and extending out over the disk are two wooden arms that I call "fences," by analogy to the fence on a woodworker's lathe. To hold the nozzle steady and as close as possible to the surface of the spinning disk, the player can rest the nozzle on the edge of one of the fences (the exterior of the nozzle has a kind of shelf that makes this easy to do). You can slide the nozzle along the fence to position it over different rings of holes to produce different pitches.

This siren's sound is very quiet. I do like the tone quality, though. It is a little nasal, with an added element of white noise resulting from air turbulence at the nozzle and around the holes.

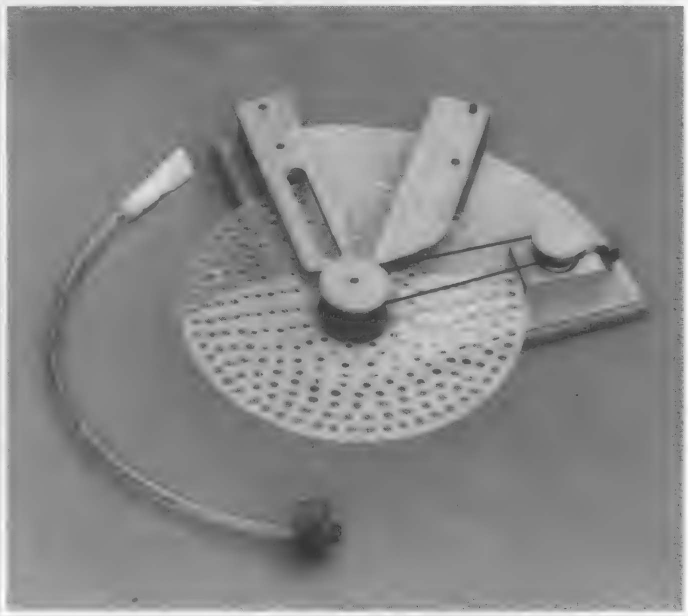


Figure 1. Simple open siren made by the author. The separate hand-held blow tube is on the left.

A slight warpage in the disk gives the tone a bit of a waver as the surface of the disk alternately approaches the nozzle more closely and then moves back as it rotates. The playing technique — moving the nozzle from place to place as you blow through the tube — is easy to master. The effect of sliding the nozzle along the fence to produce a glissando is very pretty. In part because of the scale of pitches that I happened to make available on the disk, the instrument seems to like to play a kind of mournful cowboy music.

It turns out that the number-one consideration for this sort of simple siren is: you must get the nozzle of the blow tube as close as possible to the surface of the spinning disk. And no matter how close you get it, it's still not close enough. If there's any gap between the mouth of the tube and the surface of the disk, then the air flow isn't blocked in the between-holes intervals as well as it should be. Instead, it keeps flowing, simply spreading out to the sides through the gap between tube and disk. The overall picture, then, is that when a hole passes, air rushes through and creates a pressure increase and resulting wave front on the far

*If you are not familiar with the material covered in Part 1, parts of the following descriptions may not be clear. Rather than repeating much of what was covered in the earlier installment, let me encourage you to get a copy of Part 1 and take a look at it. You can order a copy of *EMI* Vol. 12 #4, June 1997, directly from *EMI*.

side of the disk. In the between-hole interval, air escapes through the gap between the tube end and the disk surface, and creates a similar pressure increase and resulting wave front on the near side of the disk. Thus, oscillating pressure variations are being set up on opposite sides of the disk, precisely out of phase with one another. Inevitably, as the waves spread, they cancel. That's one of the reasons why this sort of siren is so quiet. The de la Tour siren described in Part 1, with its air chamber enclosure, is louder in part because this sort of cancellation is minimized.

If you try to bring the nozzle too close to the disk surface and the nozzle accidentally touches the disk, the result is a disastrous clatter. Touching also tends to reduce the speed of disk rotation, which makes the pitch go flat, especially if the motor is weak. In short, you can never get the nozzle close enough, yet you can't afford to get too close. In making my simple siren, my response this dilemma was to decide to be happy with a very quiet instrument (and also to try my hand later at building something more like a de la Tour siren, which I'll describe in a moment).

I mentioned earlier that my simple siren produces a lot of un-pitched white noise. This comes from air turbulence at the nozzle and around the hole edges. In addition, I suspect that a part of the pitched sound may come not from pulses of air through the holes, but from periodic changes in turbulence patterns, or from simple reflection, associated with air hitting the hole edges or the flat sections in between as they whiz by.

For such a quiet instrument, it's good to have a nice, quiet drive mechanism. On my simple siren I used an old reel-to-reel tape recorder motor to drive the disk. It's admirably quiet, but it has turned out to be too weak to do its job well. Someday I'll get around to replacing it with a stronger motor. The weakness is apparent in the fact the disk comes up to speed slowly and even then is prone to speed variation, resulting in unwanted shifts in pitch. A great boon for a siren like this would be a motor-speed control, which would allow tuning adjustments. Someday maybe I'll get around to that, too. For the disk's bearing, incidentally, I used one of the assemblies on which the tape reels turned from the same old tape deck — also nice and quiet.

Figure 2. Enclosed siren made by the author. The blow tube is in the lower part of the photo. The power cord (not shown) includes a foot-pedal speed-control from a sewing machine.

For the disk itself I used a disk of clear plexiglass a foot in diameter which came pre-cut from a plastics outlet. It was light and convenient, and it drilled well for easy hole-making without splintering, but as I mentioned earlier, it proved to be warped.

And what about tuning? How did I determine how many holes to put in each row to get a particular scale? The explanation gets a little involved, so rather than crowding it into the main text of the article here, I've placed it in the appendix at the end of this article headed "Scale-Making on the Siren Disk."

I built my second siren with the idea of creating a louder instrument. I wanted to test the hypothesis that an enclosure in the style of de la Tour would help increase volume by reducing the turbulence and cancellation effects described earlier. But I didn't want to make a double-disk siren in which all the rings of holes open and closed simultaneously, causing all the notes to speak at once. I wanted something on which I could play melodies, one note at a time. So I designed an instrument with a single siren disk spinning in an air-tight enclosure. Directly over the spinning disk, positioned as close as possible, is the flat lid of the enclosure. In this lid is a set of single holes — eleven holes altogether, each positioned over one of the eleven rings of holes in the spinning disk below. Mounted on the top are simple lever keys with key-heads and pads that come down over the eleven holes, so that the holes are normally closed. Pressing one of the keys opens one of the holes, allowing the corresponding ring in the siren disk to sound.

The instrument is built around an old record player. The original aluminum turntable, now full of holes, serves as the siren disk. The record player is good for the purpose, because the disk is perfectly flat, the bearing extremely stable, and the operation quiet (all standard requirements for a phonograph). I built the air tight enclosure out of wood, right around the original record player casing. I put a thick, soft gasket of sponge rubber weather strip along the tops of the sides of the enclosure, and the lid screws down over this. This arrangement makes an air-tight seal. Further, it allows me to adjust the position of the top over the turntable by screwing in and squashing down the weather strip to variable degrees. By fine adjustment I can bring the lid as close to the disk as possible without touching. I drilled a hole in the side of the housing and inserted a flexible blow tube. The original phonograph motor is too weak and slow for the purpose, being designed for a maximum speed of 45 rpm. That's less than one revolution per second, while the siren calls for a minimum of several revolutions per second. So I mounted an old sewing machine motor on the lid. The idea of using a sewing machine motor seemed like an ideal solution: it has a speed control (the foot pedal), it's stronger than a tape recorder or turntable motor, and it's available cheap ($5 or $10 for an old sewing machine from a thrift store). But it too has turned out to be less than ideal: it's noisy and doesn't have the required steadiness of speed.

As I had hoped and expected, the enclosed siren is definitely louder than my earlier simple siren, though still not nearly as loud as a true de la Tour siren in which many holes open and close simultaneously. It takes a lot of wind to operate it, but the instrument sounds equally well on the intake as on the out-blow. (As far as the atmospheric vibration is concerned, a negative puff of air is as good as a positive one). As a result, you can play strongly and more or less continuously, if you don't mind

hyperventilating. The valving system works OK, allowing you to play simple keyboard-like melodies with one hand.

However, after all that work, I find that I prefer the playing-feel and playing-motion of my earlier simple siren. I also prefer the greater expressiveness and variety of tone color that its non-keyboard technique affords. If I were to make yet another musical siren — something I would like to do someday — I'd think in terms of an improved version of the simple siren. I'd want a bigger disk for more pitches and greater range, and a good, strong, quiet speed-controlled motor with dependably steady rotational speed. To improve the volume, I'd want to have larger holes, and I might use an outside air source capable of moving more air than my lungs can manage. As for the white noise of air turbulence in the open-air siren, I wouldn't try to eliminate it. I've come to like it; it's part of the rough-edged personality of the instrument.

Appendix

SCALE-MAKING ON THE SIREN DISK

The musical intervals available from a siren disk will be determined by the relationships between the numbers of holes in each ring. But the numbers of holes will not determine the actual pitches, because they depend on the disk's rotational speed. After the disk is made and the siren is in operation, you can tune all the notes together up or down by adjusting disk speed, but you can't change the pitch relationships between them.

This appendix describes how to go about laying out the holes on a musical siren disk to produce particular a scale. I'll start the explanation with some very minimal background for those who may not be familiar with the necessary underlying musical scale theory.

The human ear seems naturally to hear musical intervals in accordance with the ratios of the frequencies of the tones involved. For example, for any two tones for which the frequency of one is twice that of the other — that is, any two tones having a frequency ratio of 2:1 — the ear will hear the interval between them as an octave. It doesn't matter what the actual frequencies are; if the frequency ratio between them is 2:1, they'll be heard as an octave apart. The same goes for other intervals: for a perfect fifth, the frequency ratio is 3:2, for a major third it's 5:4, and so forth.

By their very nature, sirens are conceptually friendly for those who want to think about musical intervals in terms of ratios in this way. On a siren disk with multiple concentric rings of holes, the ratios of the pitches available will correspond to the ratios of the numbers of holes in each ring. For instance, if one ring has twice as many holes as another, then for each rotation of the disk it will give twice as many puffs of air. The frequency ratio between the two rings will be two to one, and their tones will sound an octave apart. When the disk spins relatively rapidly both frequencies will be relatively high; if it spins slowly they will be lower; but for any given rotation speed their tones will still always be an octave apart.

The trick, then, is to make a disk with many concentric rings of holes, such that the ratios of the numbers of holes in each ring corresponds to the ratios for the intervals of the scale you want to hear. Here's a simple example: Suppose you want a six-note siren producing a basic major pentatonic scale. The intervals of this scale, identified both in musical terms and in terms of ratios, are:

Musical interval:	Root	Major 2nd	Major 3rd	Perfect 5th	Major 6th	Octave
Freq. ratio relative to root	1:1	9:8	5:4,	3:2	5:3	2:1.

To achieve this set of ratios, you can make the six rings with the following numbers of evenly spaced holes:

24	27	30	36	40	48

To produce a second octave of the same set of intervals, make an additional set of rings with the hole numbers doubled. See? Simple!

Except it's not always so simple. Suppose you want to create the same scale, but you don't want to drill so many holes. You decide to start with just twelve holes in the first ring. Then the second ring, producing the major second, should have 12 x 9/8 = ... um ... thirteen and a half holes! The half hole is a problem. How can you have thirteen and a half equal spaces between? It's a conceptual anomaly. To avoid it, the numbers of holes in the rings need to be whole numbers.[1]

The job of scale making on a siren disk, then, involves the following steps:

1) Decide what sort of scale you want and define it in ratios.[2]

2) Find a set of whole numbers having those ratios, but preferably not so large as to require an impractically large disk or an excessive amount of drilling when it comes to actually making the holes. Those who remember the arithmetic of their school days will recognize that this calls for finding the least common denominator for the set of ratios involved. Use the least common denominator as the number for the holes in the root tone's ring, and build from there.

3) Lay out the hole positions on the disk. To do this: Establish the center of the disk, and, using a compass, draw the appropriate number of equally spaced concentric rings. Then mark the holes positions on each of the rings, starting with the innermost ring/smallest-number-of-holes/lowest-intended-pitch. To figure the equal hole spacing, divide the intended number of holes into the ring into the 360 degrees of the circle, and use a protractor to space the holes the resulting number of degrees apart. (Simple example: for 8 holes, 360° ÷ 8 = 45°; thus, the 8 holes should be evenly spaced 45° degrees apart around the circle.)

4) Drill the holes. If you have access to a drill press this job will be much quicker and easier than if you drill by hand. You can set up a jig such that the disk rotates on a spindle under the drill. Position the jig for each ring of holes, and then drill the holes in succession, rotating the disk the suitable amount for each new hole.

Regarding the size of the holes, there are a couple of considerations. On one hand, for maximum volume and minimum turbulence, the holes should be as large as space allows. On the other hand, for a smooth wave form and, again, good volume, the hole diameter would ideally be about half of the distance between holes within the ring. (This assumes a round blow tube of a diameter similar to the hole diameter.) This is some-

1. Actually, it is possible to have something like a fractional number of holes in a ring, but it involves some compromise. If you space the holes as you would in order to have 13½ holes (or some other non-whole number), after completing the ring of evenly-spaced holes, you end up with a ½-sized space (or, optionally, 1½-sized space) between the last hole and the first. As the disk spins and the siren sounds, the puffs of air will pass through the holes at the desired frequency, except at the half-space point there will be an instantaneous irregularity, amounting to a sudden phase shift. The ear will hear the intended frequency, but the peculiar phase change will be heard as a kind of glitch occurring once per rotation. I've never heard this effect on a true siren, but I did have the opportunity to hear it, many years ago, in one of Jacques Dudon's optical sirens (described in Part 1 of this article).

2. Unless you really like working by trial and error, this requires some familiarity with the desired intervals and their corresponding ratios, probably beyond what I've been able to offer in this article. Many sources can help with this information, including the book *Musical Instrument Design* and the *EMI Wall Chart*, both available from *EMI*.

thing to aim for in a general way, but not something to try to achieve at all costs, because the geometry and arithmetic of the situation make it unrealistic to try to achieve it consistently in a set of many rings.

Notice that while the major pentatonic scale given above is a rather simple scale, it still demanded altogether a large number of holes. More complicated scales, with more intervals and ratios involving larger numbers, tend to require still greater numbers of holes — often *far* greater. Lots of drilling! Now you can see why the early siren makers rarely included more than four rings of holes in their disks.

In theory you can produce any just intonation scale on a siren, although the number of holes might become absurdly large. (A scale in just intonation would be one in which the intervals are defined as frequency ratios, as we've been discussing.) Tempered scales, and in particular, the 12-tone equal temperament which is standard in most western music, are another matter. In 12-equal, the frequency relationships are derived by a different sort of mathematical logic, and the resulting frequency ratios turn out to be irrational numbers. They can't be expressed as ratios, and so you can't realize such scales as varying numbers of holes in the concentric rings of a siren disk. But the situation is not as hopeless as it sounds. Remember that 12-equal was originally designed as a convenient approximation to just scales which were themselves actually preferred; so a return to the ideal of just intonation might not be seen as a loss. Furthermore, the ear is more forgiving than our friend the compulsively precise scale theorist might have you believe. Rounding off the ideal number of holes in a ring to the nearest whole number will cause some detuning relative to the ideal, but it might not be so bad as to be unlivable. A key consideration here is the number of holes in the ring. Where the number is small, one hole more or less makes a big change in pitch. Where the number is quite large, one hole more or less makes a smaller difference. So it all comes down to this: if you're willing to make a large disk with large numbers of holes in each ring and a huge number of holes altogether, you have a pretty good chance of being able to achieve least a fair approximation to any tuning, just or not, that you seek. If you choose to keep the overall number of holes smaller, then your tuning options will be quite a bit more limited. The fewer-holes option, to my mind, isn't necessarily bad: there's a kind of organic quality to music and musical systems which arise from the natural form and requirements of the instrument rather than being conceived and imposed from the outside. My quiet little 9-note simple siren, with its scale of just four notes per octave, is an example of this.

By the way, the scale on that siren disk is

Ring #	1	2	3	4	5	6	7	8	9
No. of holes	15	18	20	24	30	36	40	48	60
Ratios	3:4	9:10	1:1	6:5	3:2	9:5	2:1	12:5	3:1)
Intervals	P5	m7	Root	m3	P5	m7	Root	m3	P5
Sample scale	E	G	A	c	e	g	a	c'	e'

(Notice that I'm calling the 3rd ring the root tone. One could as well call the 4th or some other ring the root tone. The letter pitches are identified as a "sample scale" because, while the intervals of the scale are fixed, the actual pitches vary according to disk speed.)

And the scale on my 11-ring enclosed siren is

Ring #	1	2	3	4	5	6	7	8	9	10	11
No. of holes	8	9	10	12	14	16	18	20	24	28	32
Ratios	1:1	9:8	5:4	3:2	7:4	2:1	9:4	5:2	3:1	7:2	4:1
Intervals	Root	M2	M3	P5	Sept7	8ve	M2	M3	P5	Sept7	2-8ves
Sample scale	C	D	E	G	↓B*b*	c	d	e	g	↓b*b*	c

That's two octaves of a pentatonic scale including the septimal seventh (7:4), which is a little flatter than the minor seventh in the familiar twelve-tone equal temperament.

BOOKS

BOOK REVIEWS

by Bart Hopkin

JOHN EDFORS: **WOODWIND INSTRUMENTS FROM PVC: GUIDELINES FOR CONSTRUCTING EXPERIMENTAL INSTRUMENTS FROM PVC PIPE AND RELATED MATERIALS**

Published in 1996 by Stranger Creek Productions, 4671 Lyons Hill, Springdale, WA 99173. 80 pages, paper back, spiral bound; $12.00

John Edfors' book of PVC woodwinds is not just about drilling a bunch of holes in a tube. Even though the central subject matter is inexpensive plastics, the book brings a serious woodwind-maker's sophistication to its topic.

Woodwind Instruments from PVC opens with several sections providing broadly applicable information on woodwind design. Here can be found suggestions on key and pad design, raised plateaus around toneholes, bore shaping and the like. This is accompanied by notes on working and finishing PVC and ABS plastics. Thus, the book offers practical design information for any aspiring woodwind maker, whether or not his or her chosen material is PVC, and at the same time provides useful information for any instrument maker working in PVC, whether or not his or her chosen instrument type is woodwinds.

In the second half of the book, Edfors gives plans for six sample projects, including a Renaissance-style flute, a military fife, a "simulated Indian love flute," and several more. PVC construction notwithstanding, the instruments shown are quite handsome.

The computer-generated mechanical drawings appearing in the book are clear and readable even if the pixelization is coarse, just as the photos are informative even if the reproduction is not the best. The instruments range in difficulty from moderately easy to fairly demanding. Several of them require tools not always found in a typical workshop. An appendix lists supply sources for materials and tools.

BILL AND MARY BUCHEN: **URBAN SOUND PARK DESIGN**

Published in 1994 by Sonic Architecture, PO Box 20873, Tompkins Square Station, New York City, NY 10009. 21 pages, paperback, plastic "backbone" bound

Bill and Mary Buchen have been in the business of creating installations, sculpture and environments of sound for the last quarter century. In this booklet, with support from the U.S. National Endowment for the Arts, they put forth an aesthetic philosophy and a body of practical information on the creation of sound parks.

The opening pages lay out a set of guiding principles for sound environment design. The Buchens emphasize the importance of the cultural and physical environment in the locality where a sound park is to be sited. They encourage the designer to consider the importance of local landmarks and history, and to bear in mind the balance of sound, noise and quietude, both as it exists in the site originally and as it will exist in the finished park.

They go on to provide practical suggestions for site analysis, for community involvement, and finally for design and construction. They present ideas for the creation of new sound sources, as well as responses to existing sound, desirable or undesirable.

Scattered throughout these pages are historical drawings depicting early experiments in environmental sound manipulation.

In the second half of the booklet the Buchens present descriptions of four major sound parks that they have created in recent years. These include the *Science Playground* at a municipal park in the small city of Airway Heights, Washington; *PS 244 Sound Carnival* at a New York City public school; the *Terence Cardinal Cooke Health Center Garden* at a health center in Manhattan, and their contribution to the Socrates Sculpture Park in Queens. These pages are full of ideas for sound manipulation, as well as subtler ways of highlighting the qualities of the sound environment. There's even a list of "Sound Plantings" — plants which create sound in the wind.

JOHN MADIN: **MAKE YOUR OWN WACKY INSTRUMENTS**

Published by John Madin, PO Box 7082, Geelong West, Victoria, 3218, Australia. 80 pages, paper bound

Jon Madin is a credentialed music teacher, and it's clear that he's spent a lot of time with children in the classroom and out. This book, containing plans for about 50 kid-buildable musical instruments, has many of the kind of practical suggestions that teachers will appreciate. It isn't easy to create musical instrument designs that are musically satisfying and at the same time are truly simple enough for children to build. With this book Jon Madin adds a few to the list of viable designs.

Many of Madin's instruments are percussion aerophones — large diameter tubes made of semi-rigid plastics struck along the side or over various sorts of end caps to excite a definite pitch from the air within. He also includes variations on the wind instruments that we've been calling membrane reeds in *EMI*, along with several clever uses of styrofoam cups and of coil springs. A nice idea is included for making a glissando vessel flute in the form of a bottle with the bottom removed, variably dipped in a pitcher of water as one blows over the top. These are just a few samples among the many instrument-making ideas in the book.

Jon Madin has also self-published a book on simple marimba making, with accompanying cassette tape and music book.

ROBERT B. SEXTON: **METHOD FOR THE THEREMIN, BOOK 1, BASICS**

Published as part of the Thin Air Series by the Tactus Press, PO Box 9704, Austin, TX 78766-9704; 1996. 52 pages, paper back, spiral bound

Robert Sexton's *Method for the Theremin, Book 1* is the first in a projected series of books on the theremin from Tactus Press. (In the past Tactus has published books primarily on historic and ethnic percussion.) Sexton notes in the preface that this is to his knowledge the third theremin method ever made, and the only one created since the early days of the theremin in the 1920s and early 30s. More important, it's the only one ever to actually be published and made publicly available.

Sexton recommends the Etherwave theremin from Big Briar, and the book is geared to this particular model. He also recommends and gives instructions for attaching an electronic tuner to the theremin, mounted on the theremin stand, to aid the player in establishing pitch in the theremin's unmarked continuum of sound.

He comments that while it is better, with any instrument, to work with an experienced teacher, the chances of finding a teacher for one aspiring to play an instrument as rare as the theremin may be slim. Accordingly, he has tried to make the book sufficient and self-explanatory for the beginner. Repertoire, too, may be a problem for an instrument with so little written for it. Sexton suggests that existing vocal repertoire is an excellent starting place for thereminists, and this is reflected in his choice of material for inclusion in the method.

The method starts with close attention to stance, positioning, and the quality of the player's movement. Special attention is given to articulation — the clean starting of tones being a particular concern with the theremin — and the exacting hand and wrist techniques that define pitch. The book provides a number of pitch exercises (music reading ability is assumed), and a few pages of repertoire are included under the heading "Music Examples."

The author, by the way, is also a trombonist with many years behind him as a public school band director as well as lots of performance and some broadcast experience. The trombone connection is perhaps significant, qualifying him to know the joy of the glissando as well as the need to avoid *chronic* glissando — considerations which the thereminist faces from day one.

DAVID WINTERS:
NATURAL & ARTIFICIAL HARMONICS FOR THE GUITAR

Published in 1982; revised 1985, by David Winters, 103 Van Ness St., Santa Cruz CA 95060. 92 pages; paperbound

Here is an entire book devoted guitar harmonics — surely the most complete treatment of the subject available. Much of what it says is applicable to harmonics played on other string instruments as well, making it a reference of value to people interested in strings of all sorts. The author, David Winters, has written on guitar harmonics for *Guitar Player* and other magazines, and has continued, in the decade-and-a-half since this book was published, to explore the topic.

Brief background for those not already familiar with this material: Not all musical instruments produce harmonic overtones, but well-made strings under sufficient tension are among those that do (not always precisely, but closely enough). Typically all the harmonics present blend together to create a composite string tone, but in the guitar and other string instruments it's possible, through a special technique, to bring individual harmonics to the fore, letting them stand out as the main tone. When people speak of guitar harmonics, and string instrument harmonics generally, it is usually the isolated harmonic tones from this technique to which they refer. Winters has described the sound quality of the isolated string harmonics as "bell-like" and "floating."

Natural and Artificial Harmonics for the Guitar provides plenty of underlying information on the nature of harmonics. But its primary thrust is toward instrumental technique: How many different ways can harmonics be produced? What is the sounding effect of each? What are some of the unusual harmonic sounds, such as the quasi-chordal multiple harmonics, the player can learn to coax from the instrument? What are some of the techniques to allow greater versatility and variety in harmonics playing?

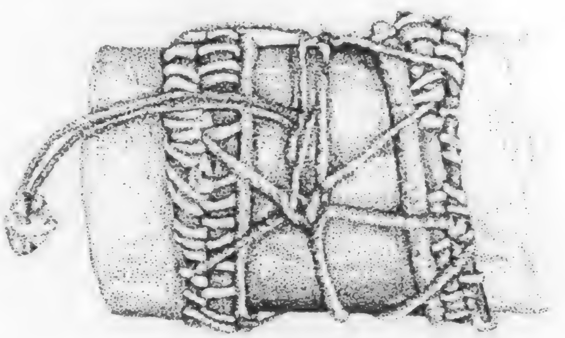
Winters provides an extensive bibliography on harmonics and related matters. He also addresses the ongoing problem of notation for guitar harmonics, where several different notational conventions remain in use, and inconsistency seems to rule. Winters' musical examples, scattered generously through the text, are taken from a wide range of sources both classical and contemporary, and they are carefully documented and credited.

This is the first in a series of illustrated articles from Robin Goodfellow that will be appearing in the next several issues of Experimental Musical Instruments. Each article presents an idea for a musical instrument simple enough to be made by children. In addition, each article contains the raw material for a lesson plan built around the instrument, featuring rudimentary principles of sound, elements of cultural lore, and a song with which the instrument can be used. With this first-in-the-series, Robin introduces the membranophones, in the form of a kid-buildable tin-can balloon drum.

BALLOON BOOM

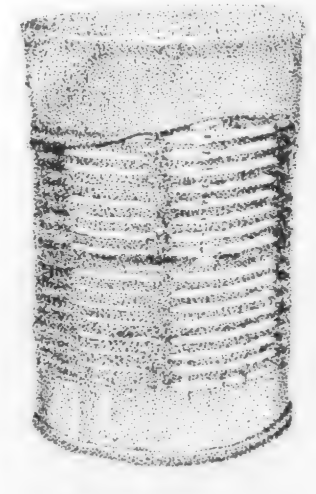
Text and drawings by Robin Goodfellow

Drums and magic have been connected in the human mind long before recorded history. The Western term, "Medicine Man" does not due justice to the concept of a healer so attuned to his society that he can effect cures from a combination of his drum beats, herbs, intimate knowledge of the person to be healed and long term familiarization with the patient's whole family.



This small drum from the former British Honduras also has a tin can body, although its skin is not a balloon

Among some African peoples, there has been a tradition whereby each person has a "drum name," and a child, if lost, can be called throughout the area by drum patterns. There are villages where the occupation of each person has its own rhythm and style of dance. Nightly village dancing prevents many problems by bringing neighbors together socially, giving everyone a chance to be supportive and also to be in the limelight. The physical exercise is good and the release of tension healing. Although this form of recreation is giving way to radio and television, and young people leave the traditional village occupations for isolating work in the city, there are still a few master drummers left who play the instruments in the ancestral style and serve their communities unstintingly.



Tin Can Balloon Drum

We in urban societies cannot sling our children on our backs and teach them complex rhythms through our bodies as we step out into the firelight dancing every night. We can, however, give them the worldwide concept of making instruments from whatever is common in our own environment, and every child can have a set of instruments for musical exploration. This series of articles is an attempt to connect caring, musically oriented adults with the children in their lives by giving background and construction ideas for a variety of musical instruments.

A drum is a piece of air surrounded by a body of something rigid and covered on at least one side with something pliable enough to resonate. Thus the body and the drumhead. Something holds them together and we have a drum. Wood is one of the most common materials for the body. Hollow trees have been covered with the skins of water animals, reptiles and mammals. Holes in the ground have been covered with animal skins and danced upon, making a hollow sound. Many forms of enclosing the air and creating the vibrations have been tried.

Cut slightly below the neck.

Here in affluent urban areas where *EMI* is likely to be read, one of the materials we have in abundance is old tin cans. We also generally have access to a supply of balloons. With no more sophisticated tools than a good pair of scissors, a balloon can be cut at its neck and stretched over the top of a tin can, and a drum occurs! Although the tone is not loud enough to inspire a troupe of dancers around a fire, it is also not insignificant.

The process is simple. Cut a balloon slightly below the neck into the bulb part and stretch it across the top of a tin can. It is important that it be stretched tightly and there be no dimple or raised part. Very young children find this difficult and will need assistance, as the balloon needs to be held with a firm grasp and pulled over the

can on both sides at once. For soup-size cans, a 9-inch balloon of good quality is desirable. Smaller cans may use smaller balloons. These drums can be economically played with chopsticks or even pencils. Holding the chopstick beater loosely, a rapid bouncing effect is possible, an imitation of a snare drum rhythm. As always when working with children, test the project by yourself first.

The drums may be decorated in a variety of ways. Two drums may be covered from one piece of standard 8½" x 11" (copy size) paper. Cutting a quarter-inch strip from the center of the page longways will make two remaining strips that will fit most cans with an overlap for gluing or taping. So many parts of the world have distinct drum cultures, that practically whatever country you may be studying with your children, you can decorate your drums accordingly. I have used Native American design symbols and have found that the addition of small colored feathers improves the project in the eyes of most children.

For very young children, using the drum as a single beat in a song such as "Sally Go Round the Sun" on the word "Boom!" is complicated enough. (See the score below.)

Another way to experience drum music and relate to a strong drum culture is to use the traditional Japanese folk song "Okina Taiko" (see the music below). Find or make a big drum and a little drum. Beat the large drum just on the words "big drum" and the little drum just on the words "little drum." "Okina" means big, "chisana" means "little," and "taiko" is the word for drum.

More sophisticated students can keep a beat or perform a rhythm on their drums. Musically adept people can handle simple and complex ostinati (short repeated patterns) underneath a song or instrumental piece. Copycat games can be devised and beginning note readers can sharpen their music reading skills reading the rhythms on their own instruments.

Grab a tin can, a balloon, a pair of scissors, a chopstick or pencil, and drum away!

FURTHER READING

Yaya Diallo and Mitchell Hall: *The Healing Drum*. Destiny Books, One Park Street, Rochester, Vermont 05767; 1989.
This is the lively account of the life of a contemporary drum-healer as he bridges cultures and traditions.

Mickey Hart: *Drumming at the Edge of Magic*. Harper Collins Publishers, 10 East 53rd St., New York, New York 10022; 1990.
Here is the drum quest journey of a famous American drummer with delightful details and insights into his process for finding out about drummers worldwide.

J.F. Carrington, B.SC., Ph.D: *Talking Drums of Africa*. The Carey Kingsgate Press, 6 Southhampton Row, London, W.C. 1; 1949.
This early work explores the use of drums as communication. The drum language of some African tribes was not only utilitarian, able to cross great distances when neccessary, but an unusual form of literature and social structure. There are descriptions of "drum names" by which persons could be called and translations of messages for organizing fishing trips and intervillage dances.

Mickey Hart: *Planet Drum*. Harper Collins Publishers, 10 East 53rd St. New York, New York 10022; 1991.
This is basically a picture book of drums from the world. The emphasis is on the drums being played in the context of the life of the drummer. It is not a dictionary of drum shapes, but a vibrant study of the drum, with photographs with colorful costumes, dramatic facial expressions and varied drum playing postures. There are also reproductions of drums in art. Informative sidebars accompany all illustrations.

Dr. Joseph Howard: *Drums in the Americas*. Oak Publications, 701 Seventh Avenue, New York, New York; 1967.
Many black and white photographs and several line drawings illustrate this exhaustive study of the drums of the Americas and those non-native drums that have influenced them. There is information on the construction of drums, including special rites and traditions observed in some cultures.

Leroy H. Appleton: *American Indian Design and Decoration*. Dover Publications Inc., 180 Varick Street, New York NY 10014; 1950 & 1971.
A good source for designs for decorating drums in American Indian style. (Pages 2-3, 22-23, and 34 contain simple designs easily copied by children.)

Robin Goodfellow is the director of Mandala Fluteworks, a studio of music and art in Oakland, CA. She has been teaching children and adults for many years, and plays flute, piccolo and tin whistle among other instruments. She is the original founder of the Queen's Ha'Penny Consort, a recorder and early instrument group that specializes in the performance of Renaissance music.

Robin draws from her extensive collection of musical instruments to provide illustrations and articles for EMI, where she has been a regular contributor for eleven years. She is developing a set of notecards featuring her drawings of instruments, most of which have appeared on the pages of EMI.

Robin can be reached at 1655 Vista Street, Oakland CA 94602, by phone at (510)530-7835 or by E-Mail at robingoodfellow@earthling.net

She would appreciate information about stories and legends of instruments, and ideas readers may have for simple instruments suitable for children to make and play.

Sally Go 'Round the Sun

Okina Taiko

CHINESE WIND-DRIVEN KITE FLUTES

by K.U. Wahl

Part I: THE HISTORY OF MUSICAL INSTRUMENTS FOR KITES

Following the invention of the bridled kite in China in the fourth century BC the Chinese name for the kite was *chih-yuan*, or paper bird. In the fifth dynasty (970-960 AD) the use of musical instruments on kites appears for the first time in Chinese literature. At that time a famous kite manufacturer named Li Yeh flew kites with an attached bow strung with a silk string. When the wind set the string vibrating, the kite, acting as a resonance box, sent out a tone. After that time, the kite in China was called *feng cheng*, which means aeolian harp.

A special form of this aeolian harp is still known today as *yao-chin*. It consists of a two-dimensional, bowed bamboo or rattan frame in the shape of a gourd with a hook at the upper side, meant to be hung on the kite string. Over this bamboo frame, seven straight, thin bamboo canes are bound across. On the canes are strung thin rattan strips with the help of tuning screws. (This is the same principle as that of the still-existing Japanese musical kite-bow *unari*). The tones thus generated reach very far, depending on the height of the kite and the wind speed.

According to a Chinese legend, the Chinese people in times of the Han dynasty were threatened by a barbarian army and were saved through the use of musical kites. Huan Theng, a famous scholar and the emperor's advisor, was called upon for a plan to defeat the superior forces of the invader. The palace walls were vulnerable only at one special place, so the enemy's forces were deployed only there. When Huang Theng stood on the walls, looking at the scene, wondering how to solve this problem, the strong steady wind suddenly lifted off his hat and made it sail towards the hostile troops. Huang Theng advised the emperor to cause several big kites to be made. Huang Theng himself made different sound devices and attached them on the kites. When the night was darkest, the kites were invisibly flown over the enemy's positions. The wind vibrating the sound devices produced low moans and high-pitched wailings. This was an unmistakable sign for the enemy that the gods were warning them that they would be defeated and so the barbarian troops fled in terror and Chinese people were saved.

The kite whistles or kite flutes, called *ko ling*, were probably developed from pigeon whistles (whistles attached to pigeons to sound as they fly), from which they differ only in weight and size. It's known from literary sources that as early as the southern Sung dynasty (1127-1279) the manufacturing of pigeon whistles was well known as a flowering craft. The sound was praised by poets as "heavenly music."

Pigeon whistles were made in five different types and had poetic names. For example, the type known as "stars, surrounding the moon" consisted of a bigger central flute made from a small gourd surrounded by smaller flutes. Every flute combination had a different mixture of sounds, depending on the manufacturer. The two main flutes were tuned in a minor third; the smaller ones in corresponding harmonizing tones. They were fixed on top of the pigeon's tail feathers by means of a little bone frame and a piece of brass wire. In flight, the light-weight flute combinations (up to four inches in size!) were sounded by the wind to produce the heavenly tones in the sky.

The flute bodies of the pigeon flutes were made of dried gourds, gingko nuts, lotus fruits, fruit shells like dried orange skins or lichees, snail shells, etc.

The flutes with the best tone quality had flute heads of whalebone, black ebony or horn, for these materials allow the manufacturing of a very sharp and therefore good-sounding leeward edge of the sound hole.

In 1908 a skilled craftsman could make three flutes a day.

Nowadays pigeon flutes are still manufactured and "flown" in Chinese towns like Hangchow, Soochow, Yangchow, Kaifeng and Beijing and in other Asiatic countries like Bali (not to mention Walnut Creek, California, where pigeon flutes collected by James Howe in China in the 1930s are, on special occasions, sent aloft on locally bred pigeons).

The bodies of the kite flutes are made of small reed-like bamboos or of bamboo veneer for the smallest flutes, while the bigger ones are made of dried gourds. The flute heads are made of bamboo or of softer woods hardened by lacquer. They need a wind speed of 15-50 km/h and are attached with natural fiber lines on bamboo laths, which are bound to the windward surface of the kite. At a kite festival in 1996 in Dieppe, France, I watched rising Chinese kites with hundreds of whistles ranging in diameter from one to ten inches. The sound of them is indescribable, something like a jet take-off with accompanying deep bourdon-tones...

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Wang Shih-Hsiang: "Pigeon Whistles Make Aerial Orchestra," in *China Reconstructs*, 12 (no.11), Nov. 1963, pp.42-43 (in English)

Part II: FLUTE CRAFT

Making a kite flute, in the form of a small whistle, 3.0 cm in diameter

Materials and Tools

MATERIALS

Fir veneer. (1 mm thickness) Strips of approx. 30 cm in length across the grain. (Scrap pieces often available gratis from woodworker's workshops! Chinese use bamboo veneer which is scarcely available in the U.S. and Europe)

Bamboo. Look for perfect material without fissures, mildew spots, insect holes or brown discoloration of the outer skin. Cane diameter approx. 6 to 10 cm, wall thickness 1 cm.

White glue for wood

Synthetic resin lacquer, high gloss or silky sheen. (Poor Chinese lacquer their whistles without color; wealthy Chinese paint them in red and gold…)

TOOLS

Pencil. For outlining

Ruler marked in millimeters

Knife No. 1. For rough carving and splitting bamboo. With sharp, short, stable blade.

Knife No. 2. For carving the sharp leeward edge of the soundhole. With long, pointed, flexible razor blade-like steel blade; for example a scalpel or "designer's knife"

Scissors. Sharp, long, for cutting the veneer

Saw. Fine toothed, for example an iron saw. Ideal is a Japanese fine wood saw, which cuts on pull and makes very straight, narrow and exact cuts

Coping saw. With fine and rough wood saw blades

Sand paper. Grain sizes 40, 100, 200; or metal-grinding blade and corresponding grinding block

Key files. Flat, half-round and round

Wood rasps. Small, key file-like, flat and halfround

Set of hand woodcarving tools. With various small hollow blades and flat blades to form the inner part of the flute's head

Whet stones. Grain 1000 for sharpening and 4000 for finishing. Important, because bamboo makes the carving tools' cutting edges wear out quickly…

Drill. For wood, with 2 mm bit for the hole through which the jig saw blade passes for sawing the windward part of the sound hole

Tube. Metal or plastic tube, outer diameter 3.0 cm. This tube will not be part of the finished instrument, but will serve as the "mold" around with the veneer strips for the flute body will be bent to form the cylindrical flute body.

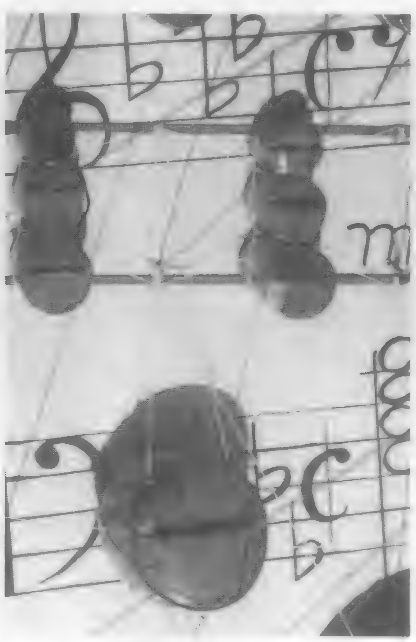
Rubber bands. For fixing the glued veneer strips around the tube while drying

→

Left: A bamboo and mulberry paper kite (original Chinese form) with 30 flutes on it, including 27 that are like the ones described in the article (arranged in groups of 3), and 3 larger ones. Two of the larger ones have gourd bodies with bamboo heads, while the biggest one has a paper-mâché body and coconut-shell head.

Center: A detail shot of the same kite with flutes. Note how the flutes are fixed on the bamboo laths.

Right: Tools required to make the kite flute.



Construction Procedure

1) MAKING THE FLUTE BODY

a) First, use the scissors to cut a veneer strip of 3.0 cm width and 11 cm length. This strip will be bent into a cylindrical shape to form the sides of the flute body. The long side of the rectangular strip should be across to the grain of the wood, because only in this manner can the strips be bent into a cylinder with the relative narrow diameter of 3.0 cm without breaking.

b) Then cut out a disk of fir veneer, 3.0 cm in diameter. This disk will be glued in place at the base of the cylinder to form the bottom of the flute body. The grain direction isn't important. Be careful. Always proceed from cutting parallel to the grain to cutting crosswise to it; otherwise the veneer will split.

c) Bevel one end of the veneer strip from step *a* so that it slopes gradually to its full thickness. This beveled end will form the inside part of the overlapping joint where the strip, curled around to form a cylinder, will attach to itself. The bevel ensures that there will not be an abrupt "step" on the inside at the point of attachment.

d) Wet the outer side of the veneer strip for prebending the strip. This prevents the strip from breaking while bending around the tube.

e) Lay the strip around the tube, glue the overlapping part with white wood glue and hold it with rubber bands while drying.

f) Slip the cylindrical flute body, now dry and freed from rubber bands, off of the tube. Set it on a flat surface with the opening up.

g) Push the cut-out veneer circle from step *b* above through to the bottom of the cylinder, while pressing the sleeve slightly on the surface (make it fit evenly with sand paper). Don't push the circle out of the sleeve. It must fit precisely with the edge of the cylinder without tension or convexity to prevent later breaking.

h) Carefully glue (airtight!) the circle to the cylinder edge from the inner side with white wood glue. Put it aside and let it dry.

2) MAKING THE HEAD OF THE FLUTE (Pictures 1 - 6)

a) Make a bamboo lath of 4 cm width and 20 to 30 cm length by splitting a piece of bamboo parallel to the grain. (The more flute heads you intend to make, the longer the lath you'll need.)

b) Carve or plane the soft, white (bamboo inner) side of the lath, making it flat and leaving a lath-thickness of 7-10 mm. The yellowish bamboo outer side remains unworked!

c) (Pic. 1) Outline a circle of 3.0 cm diameter on the hard yellowish (bamboo outer) side. Then outline another circle which is slightly bigger (3.4 cm) than the flute's diameter. Transmit the smaller (3.0cm) circle to the other (under) bamboo side, such that both outlined circles are concentrically one upon another. When you later cut this circular flute head out from the lath, cutting along the larger circle on one side and the smaller circle on the other will give you a disk with sloped sides, the top being slightly oversized. This will allow a snug fit at the top of the cylindrical flute body and leaves some room for later corrections.

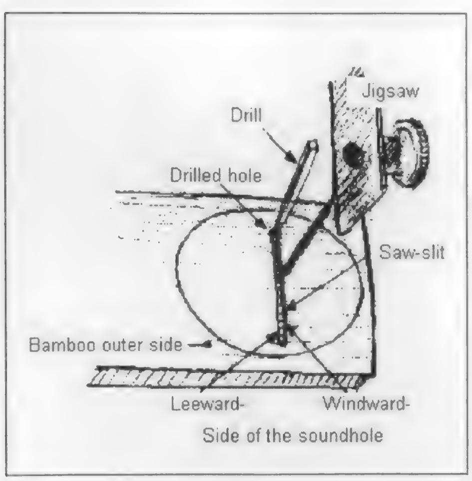
d) (Pic. 1) Mark on the hard (outer) bamboo side the windward edge (dull, later to be beveled) of the soundhole, at a distance two thirds of the flute head diameter across from the leeward side. Mark the leeward edge of the soundhole, later to be sharpened, at a distance of 2 mm to the leeward side from the windward edge just marked.

e) (Pic. 1) Now saw shallow slits in the surface of the bamboo along the two marked lines mentioned above. The distance from the ends of the slits to the outlined circle should be approximately 3 mm. The depth of the saw slits at the center will be 1-2 mm, depending on the convexity of the bamboo lath (determined by the diameter of the bamboo cane).

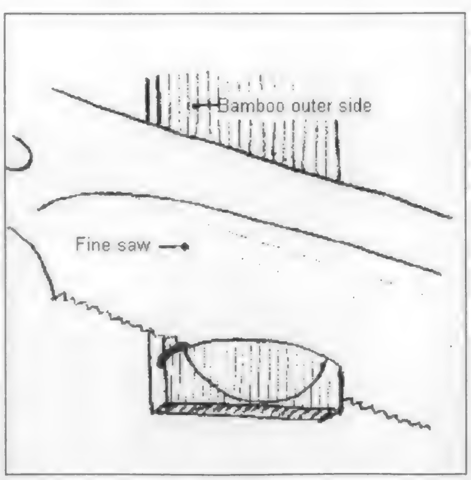
f) (Pic. 1) Drill a small hole through the lateral part between the sawed slits in order to admit the coping saw blade.

g) (Pic. 1) With the coping saw blade not yet attached to the saw, pull the blade through the hole just drilled, and attach the blade (saw teeth cutting direction toward the saw handle). Saw along the windward edge of the sound hole to a point 3 mm from the outlined smaller (3.0) circle. This saw cut will serve as a marking on the soft (inner bamboo) side for excavating the flute head.

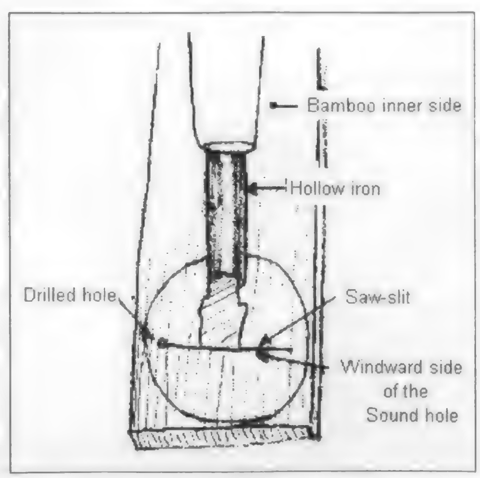
h) (Pic. 2) Now bevel the flute head by carefully sawing away the outer surface at a shallow angle beginning from windward side of the sound hole and continuing to the head's edge. The resulting sloped surface allows the flute to be blown by the wind with a bigger angle. Don't forget to redraw the carved-away outlines of the flute head.



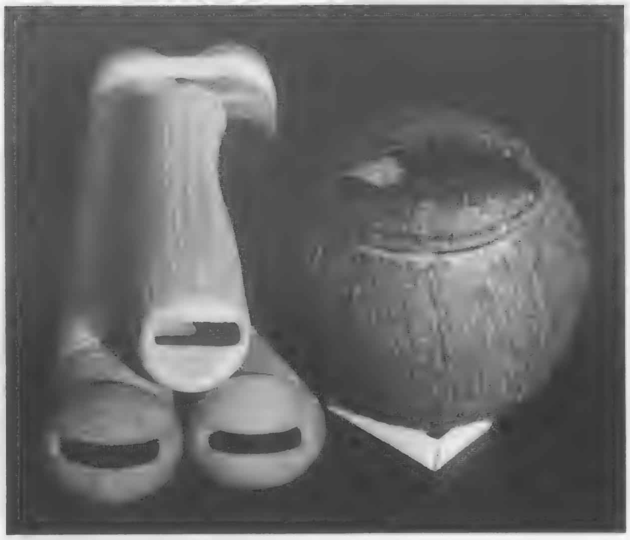
Picture 1



Picture 2



Picture 3



Left: The finished flute head, seen from what will be the inside. Center: The finished flute head and body, ready to be joined. Right: Several larger variations on the kite flute — one made of coconut shell, one of a longer section of bamboo, and two made with aluminum tubes which I took with me in my hang-glider to frighten my manbird friends...

i) (Pic.3 & 4) Beginning from the soft, white (bamboo inner) side, the flutehead is now carved out with a hollow-blade woodcarving tool from the marked 3.0cm circle on the leeward side to the coping-saw slit. Be careful that the leeward side of the soundhole, later to be sharpened, isn't hurt! It is a must for the perfect sound! Try to make flowing transitions while carving. The better you do it, the better the sound will be.

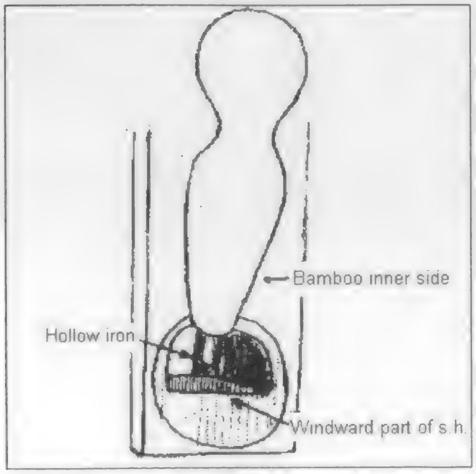
j) (Pic. 5, items 1 & 3) From the windward side of the flute head to the soundhole you can also slightly hollow out. The windward part of the soundhole is dull and has a thickness of approx. 2 mm. (Note that picture 5 shows the circular flute head, already cut from the bamboo lath. This is done for clarity in showing the final shape. However, we won't actually cut the circular shape from the lath until step m below, because it's easier to support the bamboo for carving when it's still of a piece with the rectangular lath.)

k) Finish the sound hole. If you "aim" over the flutehead in direction of the streaming wind, make sure that the "step" of the soundhole is 2 mm over its whole width. In no case should the "step" be lower toward the sides of the soundhole! Finish the lateral arcs of the soundhole with needle roundfiles and the sharp leeward part with a scalpel from the hollow side out (be careful, don't carve through!).

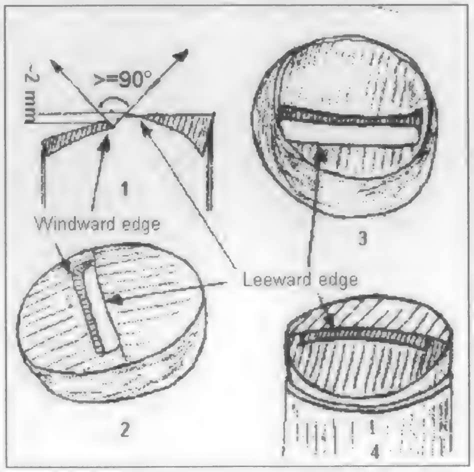
l) (Pic. 5, items 1 & 2) Bevel the plane of the dull part of the sound hole. It has to form an angle of 40-60° with the flutehead's surface; if not, the flute won't sound.

m) (Pic. 5, items 1 & 3; and Pic. 6) Now you can use the coping saw to cut the circular flute head from the rectangular lath. Be sure to follow the slightly larger (3.4cm) circle on the upper (bamboo outer) side. After cutting, sand the edges smooth and conical in the direction of the smaller (3.0cm) circle on the under (bamboo inner) side. The flute head, thus sloped slightly inward, can then be fitted into the flute's body and glued in, but only after reading carefully the next point.

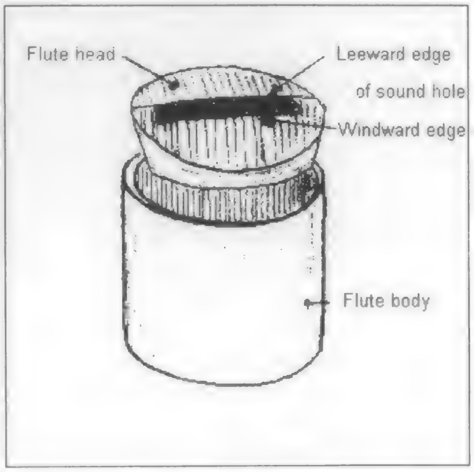
n) The rough tuning depends on the flute's diameter and length. The fine tuning can be done only in the direction of the next higher



Picture 4



Picture 5



Picture 6

tone by carefully enlarging the soundhole. You can also play a little bit by putting in the flutehead more or less deeply into the body. Tuning to a lower pitch isn't possible without diminishing the soundhole's projected area or enlarging the flute's volume.

Please note that when you test the pitch of the flute before finally gluing in the flute head, there will always be little air leaks around the unglued edges. These leaks make the flute's pitch slightly higher than it will be after the gluing is done. So it is better to try the final tuning with a little bit of glue, immediately correcting the pitch in the above-mentioned manner, and then doing the final gluing if the desired tone is reached.

Please note also that you probably will find it difficult to make the whistle sound by the airstream of your mouth because it tends to be a turbulent airflow. The whistle will sound best in a laminar airflow (and eventually some training of your mouth's blowing capabilities...). For example, you could hold it outside of your car window while driving (watch the traffic!!).

If you want to make bigger flutes, you can experiment with whole bamboo internodes, coconut shell, dry gourds, paper mâché, beer cans etc. There are many ways to produce the wind which makes your whistle sound; for example, mount it on your car or bicycle, or on a device on a string, which is whirled around the head, or....

If you decide to build a kite in order to send the whistles aloft and make your neighbors angry, fix the whistles as follows. Whistles of different sizes are glued together in groups of three, one behind the other with the above-mentioned "slope" in the windward direction. Locate the biggest whistle on the leeward, and the smallest on the windward side. There should be a gentle slope from whistle to whistle and in no case a wind-breaking "step" if you glue the whistles together. On the windward (paper- or silk-) kite surface are mounted little bamboo laths with the hard bamboo side to windward thus acting like an elastic spring. The whistle group is placed on two laths and fixed under tension with threads. These threads are fixed at a certain distance to the flute group in order to press them constantly on the underlying laths. The groups of little whistles are placed on the kite's windward surface near the top of the kite, the biggest at the rear end. The kite itself will become comparably heavy depending on the number of whistles, so it will be an absolute must to attach a line tail. Choose a windy day to make your kite laugh (what about you?) — and be careful while launching your kite! The wind develops great power at speeds necessary for the whistles! Observe the general rules for kite flying and don't expose anybody (and yourself) to danger!

Always good vibrations to you all.

Uli Wahl works as anesthesiologist in a little clinic and was born in good old Heidelberg. "We lived near the American air base," he writes, "and my father built my first kites. This was my very first contact with flying objects. One day, my brother showed me David Pelham's book Kites. *Since that time I began to make kites regularly, now for about 20 years, fascinated from catching clouds in the sky, fascinated from the beginning by the perfect Chinese constructions of bamboo and paper or silk.*

"The trigger for my building kite whistles was Christine Armengaud's very good book about aeolian musics, which I found one day in France. From that moment I began to experiment with aeolian harps and flutes. In 1993 a friend of mine, also a kite addict, came back from a kite journey in China and gave me an original Chinese kite whistle in the form described above, perfectly made of nothing but bamboo. I had no rest until I had built the first set of whistles to experiment with.

"I deeply admire the abilities which can be found all over in Asia, to make simple and therefore beautiful, fit-for-purpose products with apparently the most primitive tools. For a 1996 kite festival in France, people from 30 different, primarily Asiatic nations were invited. I watched Chinese people sending aloft big kites with one hundred whistles, and I never forgot this 'heavenly' sound!"

Uli can be reached for information at this address: Uli Wahl; Domhofgasse 21;69469 Weinheim; Germany; or Fax: +49 6201 183004 or E-mail: woineml@aol.com.

NOTICES

Bears Beat Bowls in the Bathtub, a new book/tape/guide set for children by Kathy Teck, illus. Roy Doty. Narrated by Geoffrey Holder; original music by the Hit-It Band using homemade instruments. $19.95 plus $2.84 shipping (NYS residents add sales tax). Hit-It-Kits, PO Box 139 Gedney Station, White Plains NY 10605.[13-1]

THE TACTUS PRESS. Theremin and historic percussion publications. Write for catalog: The Tactus Press, Dept. EX. PO Box 9704, Austin, TX 78766-9704. (512) 453-7779.[13-1]

Seeking information: If you have information about bamboo saxes, or other sorts of unusual sax-like instruments, builders, history, references, anywhere in the world, please contact Ángel Sampedro del Río, Scalabrini Ortiz 1960, Villa Adelina (1607), Buenos Aires, Argentina, fax (54) 541-794-3880.[13-1]

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The Jew's Harp Guild is an organization for makers and players of Jew's harps, and sponsor of the North American Jew's Harp Festival. This year's festival: Aug 15-17, Richland, Oregon. All musicians welcome! For information on the festival or on the Guild, contact PO Box 92, Sumpter, OR 97877; phone (541) 894-2345, or visit the JHG homepage: http://www.cyberhighway.net/~mposs1/jhghp.html.[13-1]

ANONYMOUS FAMILY REUNION is set for the last weekend in August, 1997 at Schlegel's Grove Campground near Bally, Pennsylvania, USA.

For information, contact "anonymous" at 3809 Melwood Ave, Pittsburgh, PA, 15213, USA, email anon@fyi.net. Whether people have been "anonymous" because of sex role oppression, possibility of criminal prosecution, rejection of egoism, mysteriousness, obscurity, sense of humor, or whatever, we have our "anonymity" in common — & I think it's time we met. [12-2]

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Information wanted about the horned violins made in Burma, or if anyone traveling to Burma would like to help with some research for a future *EMI* article, please contact: Cary Clements, 1197 South Van Ness Ave., San Francisco CA 94110; phone (415) 206-9531; e-mail stroviol@earthlink.net. [12-4]

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Musical Instrument Design: Information for Instrument Making, by Bart Hopkin, editor of *Experimental Musical Instruments,* published by See Sharp Press. *Musical Instrument Design* presents underlying principles for the design and construction of acoustic musical instruments of all sorts, with a practical, hands-on approach. NO OTHER BOOK book gathers this information under one cover. Just under 200 pages long; large format; fully illustrated. $18.95 plus $2 s&h. (No shipping charges for U.S. air mail or overseas surface rate; for overseas air add 25%. Customers in California add 7.25% sales tax.). Order from *Experimental Musical Instruments*, PO Box 784, Nicasio, CA 94946, USA, phone/fax (415) 662-2182. [11-4]

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SLATE

by Will Menter

For many years I lived on a farm called Watercatch, near Bristol in the west of England. In the field behind it was an enormous underground tank, built early this century as a water supply. The sound was great after rain — drips from the roof and a long, long reverb. I made some beautiful recordings down there. This farm brought together lots of my musical interests. I had done several performances with dripping water before I moved there, and developed it further while I was there. Next to the farm were woods with lots of dead sycamore in, which kept us warm in winter and provided the material for making rope-ladder-style log xylophones in summer.

The field in front of the farm was called "Slate." I don't know why, but it pointed to another direction, because in 1986 I spent three months working 200 miles away in the slate quarrying area of North Wales around Mount Snowdon. A beautiful area — high mountains and steep valleys, remote sheep farms, and in the distance, the Irish Sea, the sandy beaches of Ynys Mon (the island of Anglesey) and on the Llyn Peninsula, the Whistling Sands of Oer. The sands whistle, says the tourist brochure. I was convinced it must be something to do with the wind or the sea and kept listening harder and harder (if that's possible) but could hear nothing apart from waves, wind and a distant diesel generator. Maybe the weather wasn't right for sand whistling. Then a group of children ran past, and the sand was squeaking under their feet! So I ran too and the sand squeaked for me. Or creaked, I'm not sure which, but that must have been it, the whistling. After all, I reasoned, the "Squeaking Sands of Oer" wouldn't do much mileage as a tourist spot.

Dinorwic Quarry

But the sands were a diversion which I'd explored on one of my days off. The main thing was that here I was at the very heart of the slate industry, surrounded by unlimited supplies of this wonderful material. During the 18th and 19th centuries slate from Llanberis, Bethesda and Blaenau Ffestiniog was shipped all over the world for use as a roofing material — as far as Valparaiso in Chile for example. The quarries employed thousands of craftsmen and laborers and were responsible for roofing the factories of the early industrial revolution in Manchester and the north of England. This was part of the complex jigsaw of social and geographical conditions that led England to industrialize its production earlier than the rest of the world.

The stone is gray. But each quarry has its own distinctive shade — green, blue, purple and even red. The red is unusual, but has such a lovely warmth to it. It's a sedimentary rock, formed from layers of mud at the bottom of the ocean, then metamorphosed through heat and pressure. And it has such a strong horizontal grain structure that it can be easily split with a chisel into sheets 5mm or less thick which are still strong enough to withstand the battering of wind, rain and hailstones on roofs for a hundred years or more, and the battering of wood and rubber percussion beaters for — well, for how long? I don't yet know, but the first instruments I made with slate are now over ten years old and are going strong.

What instruments? Slate marimbas, llechiphones. Although I don't speak Welsh it seemed right to give them a name based on the Welsh word for slate (*llechen*, singular; *llechi*, plural). The form is similar to a wooden marimba. Slate bars about 5mm thick are supported on rubber tubing at their nodal points. Underneath each bar is a plastic resonating pipe. Beaters are rubber balls on wood or leather-bound wood. Tuning is by grinding underneath with a file or (quicker but noisier) an angle grinder.

What do they sound like? Probably much mellower than you'd expect. More like an African marimba than an orchestral one, something like a metallophone but not such a long ring. A unique sound, and I'm surprised it hasn't already been used much more. Some people have compared it to a harp too, but while I can hear a similarity I think it is also to do with cultural associations since

Photos, this page:

Left: Slate Beach, Porth Penrhyn, near Bangor

Below right: Archive photo of a bugler signalling blasting

Below left: Slate fences above Penrhyn Quarry

the harp is an important instrument in Welsh folk music.

What tunings and ranges? I've made them from C_1 (two lines below the bass clef) up to G_5 (an octave above the treble clef), but the tone is strongest, and most distinctively slate, between C_2 and G_4. The tunings have been strongly influenced by the first one I made. Seven slates split from one rock, all the same length but different thicknesses, turned out by chance to be a five tone scale: D_2, E_2, G_2, Bb_2, C_3, D_3, E_3. I love this scale. It's very encouraging for workshops because it is so harmonious, the notes forming a ninth chord if played together, and at the same

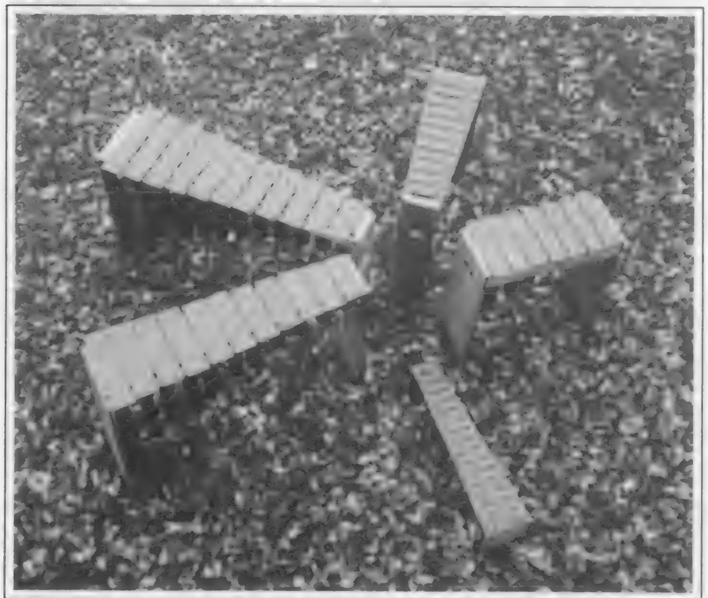
time, because of the tritone between E and Bb, it's not as bland as the more common pentatonic C D E G A. One of the reasons I responded positively to this initial accident of tuning was that I'd heard this scale used in the beautiful music of Hukwe Zawose from Tanzania. So I've made a lot of llechiphones on this scale. I've also made many fully chromatic models, and many less usual tunings. My particular favorite at the moment is an equipentatonic tuning, where the interval between each key is 2.4 semitones. For a while I made a standard range of llechiphones which I made available for sale, but now I just make to commission, and try to respond to individual needs.

In the area around the quarries, slate is used not just for roofing, but all sorts of other things — floors, walls, work surfaces, doorsteps. Driving down the

narrow mountain road to Penrhyn Quarry in Bethesda, a twenty foot high slate wall suddenly borders the road — rich dark gray — and at Porth Penrhyn near Bangor the whole beach is made up of thin shale-like slates stacked on their sides making a wonderful accidental sculpture. Back on the mountainside many of the fences between the narrow fields are made with huge slabs of slate sunk into the ground and tied together with wire. Born of practicality and necessity, but giving the area a unique sculptural landscape. Even more dramatic is the town of Blaenau Ffestiniog. Ten miles inland and south of Mount Snowdon, it seems that all you can see is slate. Here the slate is mined underground rather than quarried, but huge man-made mountains of waste slate surround the town and merge with the distant green hills. The scrap makes a great sound too. You sometimes hear wild goats running over it. Walking over it yourself is a musical experience either listening to your footsteps or selecting pieces that you like the sound of and pocketing them.

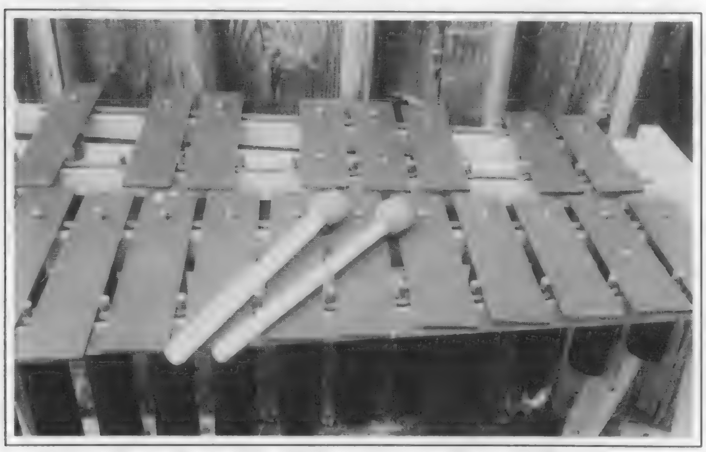
And yet . . . this is a romantic view. I struck up a conversation with a young woman in a pub in Blaenau Ffestiniog. "I don't know what you like it for," she said. "There's nothing here except slate and sheep and rain." Slate has become a relatively expensive roofing material so most of the quarries are now closed, and it's

Will Menter with llechiphones



Above: Five llechiphones

Below: Detail of chromatic llechiphone



an area of high unemployment with few opportunities. Traditionally quarry work was hard and dangerous, and many local people regard the tips as a monument to the grueling labors of their fathers and the lives lost through accidents and industrial disease. It's only a minority that would prefer the tips to be grassed over and forgotten about. While this young woman was desperate for some excitement in her life which she knew she was never going to get from slate, she'd never managed to travel further than Colwyn Bay, a coastal resort about thirty miles away.

Slate also symbolizes the exploitation of Wales by England — or rather the English bourgeoisie. Many of the quarry owners and bosses were English, while the laborers and craftsmen were Welsh. The craft of working slate can't even be properly discussed in English, because there are many technical terms in Welsh that have no English equivalent.

I started my experiments with slate as a musical material in 1986 during a residency at the slate museum in Llanberis. I was ignorant of the dangers. Tuning with an angle grinder in a public corridor, slate dust filled the air but I was quickly informed that once the dust gets in your lungs it stays there, so a face mask and good ventilation were essential for working with slate. During my residency I soon came to recognize the feeble walk and posture of some of the older men in the area whose lungs had been ruined by long exposure to the dust. In the 19th century some quarry owners had even claimed that slate dust was good for you. Of course the quarry workers all knew it wasn't, but it took until the 1970s for official recognition and compensation to be given for industrial disease caused by the dust. All the stewards working in the slate museum were former quarry workers and I learnt much from them and struck up friendships with a couple of them.

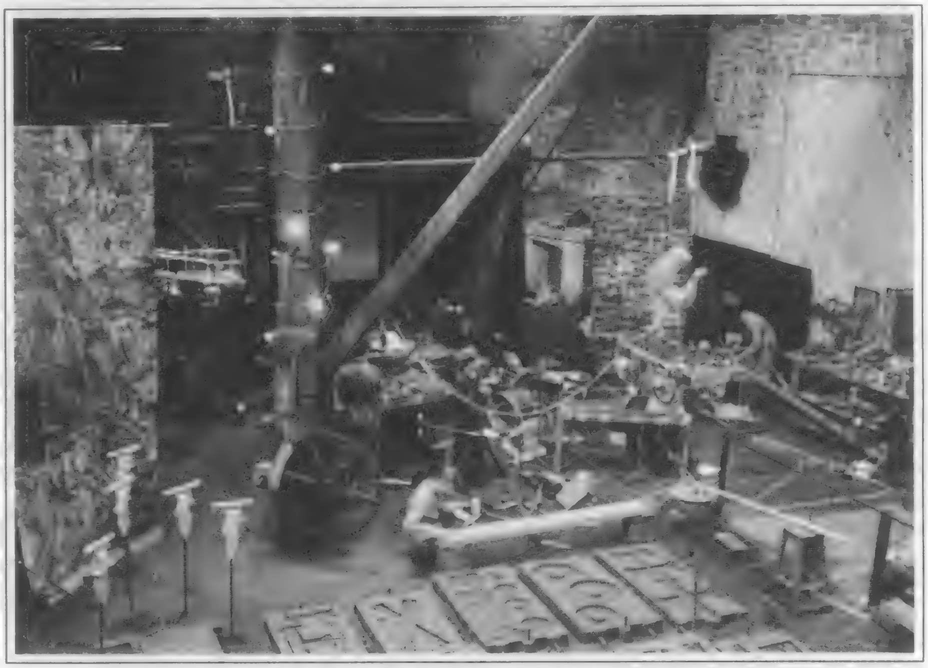
I came to love the area and after the residency was finished, started visiting regularly. Like a lot of instrument makers, ulti-

mately I am more interested in music than instruments — or rather I see instrument making as being part of the creative process of music more than an end in itself. Some of the other parts of this process are well known — composing, performing — but sometimes overlooked are listening and, perhaps most important of all, creating a physical and social context for all these activities to happen. My approach to music making is to be involved with as much of this process as possible.

I gradually developed the idea that a performance that was about slate, that used slate to make the sounds and that was performed in the heart of the slate quarrying area would be particularly resonant (not just acoustically) and I set my heart on achieving this. The musical idea was expanded to include other art forms. I commissioned six poems from Gwyn Thomas and set them to music to be sung by Sianed Jones and five other musicians. The music was built up around the llechiphones, but also incorporated traditional instruments — sax, violin, trombone, bass viol. Sculptors Andy Hazell and Lucy Casson made a set out of scrap and industrial materials that echoed the landscape of the quarries. Textile artists Annie Menter and Barbara Disney made batik backdrops that drew attention to the colors and shapes in slate, and also drew on the local tradition of engraved slate fireplaces. Andy also took many slides of the slate area, edited some archive film we found of work in the quarries and manipulated a complicated three-screen projection system while the musicians played. All this eventually came together in the form of a cross-artform performance called *Cân Y Graig — Slate Voices*.

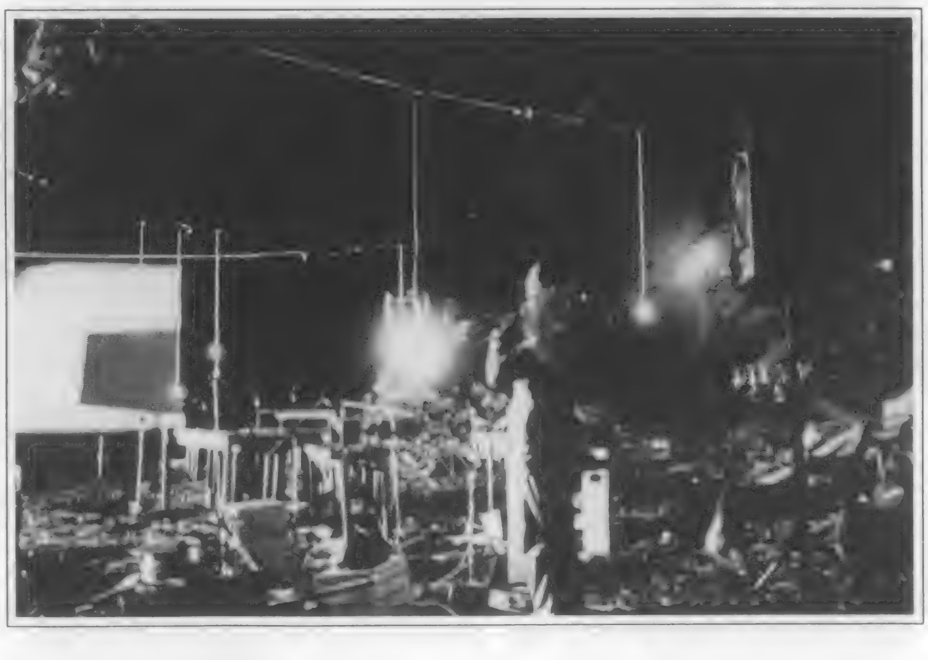
We performed *Cân Y Graig — Slate Voices* fifteen times in six different locations in 1990. Two of them had this special resonance that I was looking for. The first was the slate museum itself in Llanberis. The space we used had been the foundry for the second-biggest quarry of all and still had the original furnace and industrial saws and planes powered by an enormous waterwheel. Here we had the most complete exposition of our material. But more exciting for the audience and acoustically more resonant were our underground performances at the Llechwedd slate mine in Blaenau Ffestiniog. Four hundred feet underground, the audience had to wind their way down low-roofed tunnels carved out of the rock to reach the enormous cavern which had once been a solid, silent mass of slate but was now an equally silent void beside an underground lake. Each person present at the performances could only guess where the particular slate whose space their own body now occupied had ended up — as far away as Rio de Janeiro, or as near as the waste tip by the mine entrance. Our performance lasted for about an hour and at the end we moved beside the lake to read out a litany of the names of quarry workers who had died in accidents. For evoking the life and work of slate workers over the years this context couldn't be surpassed and many of the audience said afterwards they were deeply moved by the experience.

Cân Y Graig — Slate Voices was definitely the high point of my work with slate so far but I have gone on making slate instruments and using them in lots of different music. For example I combined them with Zimbabwean mbiras in a more recent



Above: Performance of *Cân Y Graig — Slate Voices* in Welsh Slate Museum

Below: Performance of *Cân Y Grain — Slate Voices* in Llechwedd Slate Mine



project called *Strong Winds and Soft Earth Landings*. The tuned slate marimbas I suppose are my main slate instruments, but just as interesting are simple hanging chimes made from random pieces of slate ranging from a few centimeters across up to almost a meter. As with most percussion instruments of this type, the bigger ones are dominated by overtones rather than the fundamental pitch and give very rich individual tones. I've set them up as wind-blown instruments and also in arrangements as mobiles where they collide with each other producing more random rhythms and series of sounds.

At the moment I'm working on a project to bring together my interests in water and slate. I took five of my llechiphones outside and placed them underneath a large oak tree, so I could stand on one of the branches and take a photograph looking down. When it started to rain a few minutes later, my first thought was to rush the instruments back inside, but before I had a chance to do this I noticed what a great sound the big drops of water falling off the tree were making as they hit the slate. So instead of taking them in, I brought my tape recorder out and recorded it. Later I used this tape in a piece with two singers, but I also had a prototype design for a new instrument — the dripping llechiphone — which should be finished this summer. My plan is to use this in an installation with a development of another water instrument of mine, the gurgler. This one consists of a set of plastic drainpipes standing in a bowl of water with air bubbling up inside them through a hose sprinkler. The sprinkler turns slowly and delivers bubbles under each tube in turn, making a deep pitched gurgling sound. The idea was inspired by listening to bath water gurgling as it emptied. The sound I was going for was more of a glugging than a gurgling but the instrument has turned out to sound nothing like this! All this should come together in some performances and installations in mid-1998.

It is planned to release two CDs of Will Menter's music and instruments in autumn 1997: *Cân Y Graig — Slate Voices* and *Strong Winds and Soft Earth Landings*. For details of these and of his instruments, contact Will at:

Buscatch, 152 Cheltenham Road, Bristol BS6 5RL, England phone/fax +44 117 924 3390, or Atelier Des Neuf Portes, Changey, 71360 Saisy, France phone/fax +33 3 85 82 08 67

Will Menter lives in Bristol in the west of England and Burgundy in central France. He has been working as a musician, instrument maker and composer for nearly twenty years. He directs resOnance, *a group that produces cross-art-form performances using music, sculpture, film and dance. He plays soprano sax as well as his slate instruments, and he is involved with Zimbabwean mbira music. He has made music sculptures for public participation in many places such as Grizedale Forest in the north of England.*

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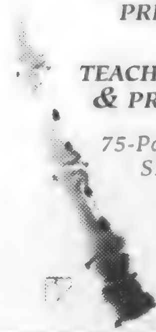

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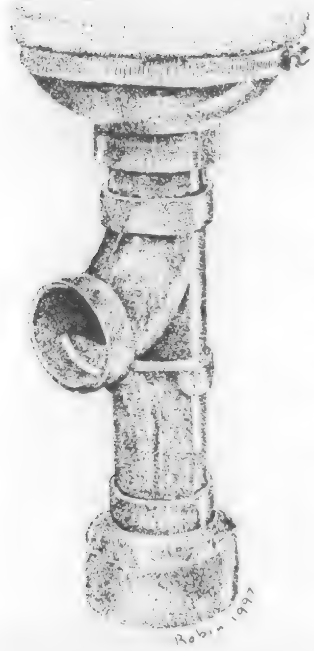
BUILDING MODULAR DRUMS FROM PLASTIC PIPE AND PLYWOOD

by Bennett Cohen



I became interested in unusual musical instruments during a short stint as the assistant director of the Collegium Musicum at the Oberlin Conservatory of Music. I was in charge of the group's large collection of early instruments and had to learn how to play all of them. The relative simplicity of most early instruments provided a good grounding in fundamental principles of musical instrument design. We had some top-quality renaissance flutes with straight cylindrical bores in the collection, and one day while wandering through a large hardware store I noticed that our flutes looked to be about the same diameter as 3/4" PVC pipe. On further investigation, I discovered that 3/4" schedule 80 PVC (which is a little thicker than ordinary schedule 40 PVC) had the exact same inner and outer diameters as our best renaissance tenor flute. Armed with advice from *EMI* and Trevor Robinson's fine book *The Amateur Wind Instrument Maker*, I have since built all manner of transverse and end-blown flutes and whistles from PVC pipe (photo 1).

I expanded into drums when a friendly general contractor gave me some scrap pieces of 6" diameter PVC sewer pipe left over from a construction project. I found some old drum hardware and large calfskin bongo heads which fit, and narrowed the other ends with some 6" x 4" reducing couplings to make some fine sounding congas (photo 2). While I lucked out with these congas, my later efforts at building drums from scraps of 6" and 8" diameter PVC pipe were less successful. The end results rarely justified the expense of commercial hardware and drumheads, or the considerable effort involved in fashioning my own tensioning hardware (since I don't weld). Also, I was having trouble finding free or inexpensive scraps of large-diameter pipe, and was not inclined to invest in a 20' length of the stuff from a plumbing supplier. If I was going to keep experimenting with drum designs, I had to find a simpler and cheaper approach. My solution has been to concentrate on building small hand drums and tube drums from 6" or smaller diameter PVC and ABS pipe and fittings, using thin plywood as a drumhead.

The many advantages of PVC and ABS pipe as musical instrument building materials have been extolled here and elsewhere. Plastic plumbing pipe is relatively cheap, widely available, easy to work with, has good resonating properties, and comes in lots of diameters. The larger diameters of pipe (between 8" and 14") for building big, conga-like drums can be expensive, hard to find, and are usually only sold in 10' or 20' lengths; however, most home centers stock 2", 4" and 6" PVC and ABS pipe and fittings — large enough diameters to build smaller hand drums and tube drums. Pipe of these sizes is not too costly, and is often sold by the foot. There is some concern over these materials' potential toxicity, but my impression and experience so far is that they are safe enough if one follows common sense safety precautions like wearing a dust mask when cutting.*

One feature of PVC and ABS plumbing supplies that I haven't seen much used in instrument building is their modularity. Any large home center or plumbing supply store will usually have an aisle or two devoted not just to pipe stock, but also to displaying all sorts of fittings: straight couplings, reducer couplings, bushings, elbow joints, T fittings, drainage devices, etc. (I have no particular knowledge of plumbing, and can't guarantee that I'm describing these things accurately — I just use the terminology that I pick up from the store displays and less laconic countermen.) These myriad plumbing supply parts are designed to fit into each other with sturdy, airtight seals. If one could construct good, cheap hand drums based on 4" and 6" PVC or ABS pipe and fittings, it should be possible to exploit the inter-connectability of these plumbing parts to try out all sorts instrument designs. One could experiment with pitch by building hand drums which allow for interchangeable resonating tubes of varying lengths. One could experiment with design by building drums in unusual shapes. Or try futzing around with the ergonomics of playing technique by building instruments with multiple drum heads, or resonators that can be adjusted while playing. One could even fashion percussion instruments which could be broken down into their constituent parts and reassembled in a modular fashion.

The membrane material that makes all this experimentation practical is thin plywood. Traditional drums use stretched animal skins or plastic heads for membranes. Animal skins can be expensive and their tension tends to vary with changes in temperature and humidity — a problem for building drums which must produce specific pitches. Synthetic drum heads are more stable, but only come in a limited number of relatively large sizes, from a hand drum perspective. Both animal skins and synthetic heads usually require elaborate, cumbersome and expensive tensioning hardware. These factors inhibit free and easy experi-

*[From the editor] The question of the toxicity of these plastics has often come up in *EMI*, with some people suggesting that potential toxicity is cause for concern, and others suggesting that such concerns are exaggerated. As the author suggests, common-sense precautions should apply: PVC and ABS give off fumes when heated, so in any case where the materials will be heated, or where fine dust may be produced, including cutting and sanding operations, a mask should be worn. For applications involving oral contact, such as wind instruments, anyone sensitive to toxicity concerns might choose to avoid using these plastics in mouthpieces.

mentation in instrument design. What's needed is a membrane that is cheap (or at least not disproportionately expensive to the pipe stock involved), and can interact easily with any size PVC and ABS pipe, preferably without lots of tensioning hardware.

Thin plywood glued directly onto pipe is pretty good solution. Many large home centers, specialty woodworking stores and hobby shops carry plywood in thicknesses between 1/8" and 1/32". I've seen it sold in sheets as large as 1' x 4' under the brand name Midwest for about $3 per square foot. While the resulting instrument is technically not a membranophone because the drumhead is not stretched, thin plywood glued directly onto a shell acts partly like a membrane and partly like a sound board. For drum building, the trick is to find a thickness of plywood relative to the pipe diameter which maximizes the membrane qualities. For 4" and 6" pipe, I've found that 1/16" (1.6 mm) plywood works well. 1/8" (3.2 mm) plywood is too stiff, and 1/32" (0.8 mm) plywood is too flabby.

This approach is not without its drawbacks. Using plywood as a drumhead means giving up some volume and timbral brilliance that a genuine stretched membrane would produce. However, it provides a quick and inexpensive drumhead that interacts easily with pipe of any particular diameter. Plywood is also a stable membrane, which is important for building tube drums or other specifically pitched percussion instruments.

My general approach to modular drum building is to build what I will call a drum body (a resonating chamber and drumhead) which can interact with resonating tubes or other drum bodies. For the basic drum body I've found that large couplings, floor drains, drainage catch basins, or other fittings with two or more openings work well (photo 3). Simply glue thin plywood over one

Photo 1.
PVC flutes: transverse flutes (right), end-blown cana (left), and auloses from commercial penny-whistle fipples and 1/2" CPVC pipe (bottom).

Photo 2 (far right).
Conga drums from 6" PVC pipe.

Photo 3.
Materials (clockwise from left): drainage catch-basin, 4" PVC T fitting (drainage schedule), floor drain, 4" ABS straight coupling, 4" x 2" ABS bushing; all sitting on a 1' x 4' sheet of 1/16" plywood.

Photo 4 (far right).
Adjustable-pitch doumbek. Interchangeable pipe lengths are numbered (upside-down in photograph) for easy combination. For a full-sized print of this photo, see this issue's front cover.

of the drum body's openings with a glue that can bond wood to plastic. I use cyanoacrylate glue, also known as superglue, which is available in decent-sized tubes at woodworking stores. Although many superglues claim to bond in seconds, I've found that it helps to put some weight on the plywood/plastic bond and let it dry overnight.

After the piece of plywood is glued onto the drum body, trim off the excess overhanging plywood with a router and flush-trim bit. Careful cutting with a fine-tooth saw should also work. Sand the plywood edge smooth. Coating the plywood head with polyurethane varnish, paint or other wood coating will smooth and protect it without appreciably changing the pitch or tone.

Once this basic drum body is built, you can stop there or experiment with various resonators. The drum body will have a natural resonant frequency, and a length of pipe which reinforces this frequency will add to the drum's overall volume and resonance. A convenient way of auditioning different lengths of pipe is to cut several short pieces of graduated lengths, which can be coupled with each other and longer pieces to make sample resonator tubes of any given length. For instance, I keep handy a set of pieces of 2" diameter ABS pipe in lengths from about 1.5" to 2.75" in quarter inch increments, plus 5" and 10" lengths. With a few couplings I can combine these pieces to get sample resonator tubes of any length up to about 2 feet. Once I arrive at a length which sounds good on a given drum body or produces a desired pitch, I can cut a single piece of pipe to that length.

Some observations to keep in mind when trying out designs. Since the tension of a glued-on plywood head can't be adjusted, the factors which determine pitch are the diameter of the drum head, the thickness of the plywood, and the shape of the resonating chamber (length, volume and open-endedness). If several drum bodies are connected directly to each other, they will share the same resonating chamber which will tend to impart its pitch and timbral qualities to all of the drum heads. In such instruments, the only way to get meaningful pitch differential is to use different-sized drum heads. Also, the resonating chambers need to stay relatively small in order to produce recognizable pitches from 4" and 6" plywood heads.

The rest of this article will be devoted to concrete examples of some of my more successful modular drum designs. My favorite design I call the adjustable-pitch doumbek. This drum uses a plastic floor drain for a drum body. The drain is bowl- shaped, with a removable grate on the large opening (7" diameter) and a small opening which accepts 2" ABS or PVC pipe. These floor drains cost about $5.00, and are manufactured or distributed by Prairie Home Products of Grandview, MO. I remove the grate, glue the plywood to the large opening, attach a specific length of 2" ABS pipe to the small opening, and then attach a 2" x 3" ABS coupling as a flare on the end. The resulting drum looks and plays like a middle eastern style doumbek. The length of the pipe determines the pitch of the drum. Shorter lengths of pipe can be combined using couplings to make longer lengths, and as a result one can obtain a scale's worth of pitches using a small number of pipe lengths alone or in combination (photo 4, preceding page). Because of the natural resonant frequencies of the floor drain drum body, some pitches will sound fuller and louder than others.

Photo 5 (above). Modular bongos, shown with 4" x 2" reducer coupling.

Photo 6 (below). Two-headed elbow drum.

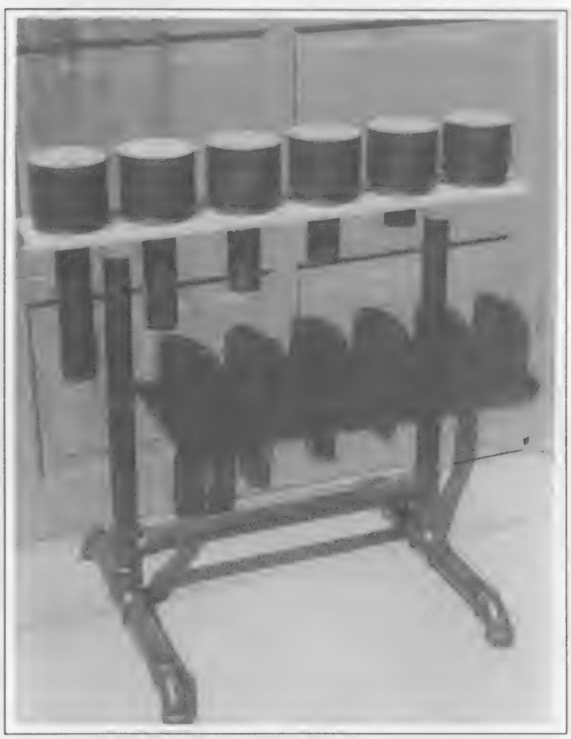
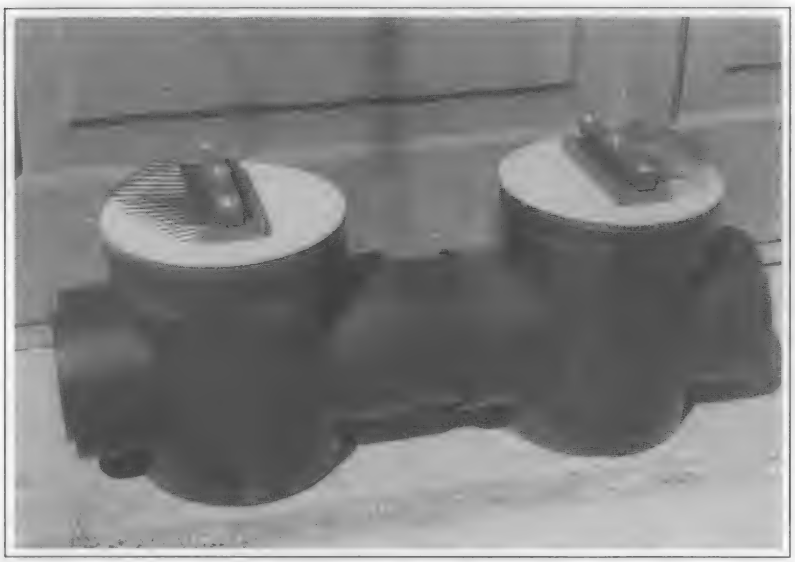


Photo 7. A six note tube drum instrument.

Photo 8 (above). Doumbek-style drums with calfskin heads.

Photo 9 (below). Double kalimba.



To obtain the smallest set of pipes which produce the pitches of a given scale I use the following approach. Start with the shortest piece of pipe which produces an acceptable pitch, then cut a pipe length for the next note of the scale, and so on. Throughout this process, try coupling together lengths of pipe which have already been selected to see if these shorter pieces can combine to make a longer length which produces a desired note in the scale. You will eventually reach a pipe length which produces the drum's lowest recognizable pitch. Four or five well-chosen lengths of pipe may suffice to produce a full octave diatonic scale, with an accidental or two thrown in.

A cautionary note: I've found that identically constructed drum bodies don't always produce the same pitch — they sometimes vary as much as a semitone or two. I suspect that this is due to slight variations in the thickness or density of the plywood or differences in the superglue-to-plastic bonds. The effect of these potential variations is that a length of pipe which produces a given pitch with one drum body will not necessarily produce the exact same pitch when attached to another similar drum body. As a result, you may have to go through the pipe length determination process with each differently pitched drum head.

My other favorite plumbing supply drum bodies are drainage catch-basins: black plastic cylinders about 8" tall and 6" in diameter with one or two side holes which accept 4" drainage schedule pipe. They are manufactured by National Diversified Sales, Inc., of Newbury Park, CA, and cost about $6.00 at most home centers.

I've used these drainage catch-basins to make a modular hand drum / bongo-type instrument. First sand over the top of a one side-opening basin to smooth out any irregularities left by the injection molding process. Glue plywood over this 6" diameter top. This is the basic drum. Attaching a 4" x 2" drainage schedule reducer coupling to the side opening lowers the pitch by a fifth and improves the timbre. This incarnation makes a wonderful child's drum because it is sturdy, has no small parts, will sit on the floor, and is not too loud.

This drum can be converted into a pair of bongos by replacing the 4" x 2" reducer coupling with a 4" T fitting. The middle of the T goes into the catch-basin with a short sleeve of 4" drainage schedule pipe, and the top opening of the T is covered with a plywood head. The 4" x 2" reducer coupling can be attached to the other end of the T to lower the pitch and improve the resonance. The three basic pieces can thus be combined to make four different drums (photo 5).

A two-opening drainage catch-basin permits two plywood heads on the same drum body. One good design for a two-headed drum body uses a 4" PVC elbow fitting on the other small opening. The two heads provide high and low drum pitches, and the low pitch can be bent by moving one's own elbow in and out of the PVC elbow's opening during playing (photo 6). The resulting drum (which I call a two-headed elbow drum) sounds quite tabla-like.

The last example is a set of tube drums, not unlike the Balimbafons and Kydex drums in Reinhold Banek and Jon Scoville's *Sound Designs* (Ten Speed Press, 1995 and 1980). My twist on their approach is to build separate drum bodies out of 4" ABS straight couplings which accept 2" ABS pipe resonators. Attach a plywood head to one side of a 4" ABS coupling, and attach a 4" x 2" ABS reducer bushing to the other end to accept the 2" ABS pipe. The lengths of 2" pipe determine the pitch of the individual tube drums.

This approach has several advantages over tube drums made from straight 4" pipe, especially for a big instrument with lots of notes. Because each note uses a 4" chamber going into 2" pipe, given pitches can be obtained with shorter lengths of smaller, lighter pipe than would be needed for a straight 4" tube. A large multi-note instrument can be built considerably smaller, lighter and cheaper this way. Since different 2" resonating tubes can be easily removed and inserted into the 4" drum bodies, a few drum bodies can share a larger number of resonating tubes. This beats having to produce a separate tube drum for each desired pitch, especially if one only needs a few pitches at a time. Also, the individual tube drums can be easily mounted onto 1" x 6" boards or other surfaces by cutting out holes for the 2" pipe and supergluing the coupling/bushing drum bodies onto the surface (photo 7). As with the doumbek, certain pitches will be stronger than others due to the natural resonant frequencies of the 4" coupling/bushing drum bodies. I particularly like the fact

that this instrument can be played with hands, as well as with mallets. I think the hands-on playing technique is much more engaging and visceral.

These are my most successful pipe and plywood modular drum designs. I have also stretched calfskin heads over the floor drain and larger 6" x 4" reducer couplings, using heavy-duty rubber bands to hold the soaked skins in place and pipe clamps to secure them. I've made some excellent sounding adjustable pitch doumbeks this way, although the pitch does vary somewhat with the taughtness of the head. A telescoping or otherwise adjustable resonating tube could compensate for changes in the pitch of the drum body — one could keep several graduated lengths of resonator pipe handy, or try out some of the continuously adjustable resonator tube ideas featured in back issues of *EMI*. Another approach to using stretched skin would be not to try to obtain precise pitches, but to use different pipe lengths to obtain just a few higher and lower notes. I've made an interesting double-pitched doumbek using a T fitting midway through the resonating pipe — the opening of the T can be covered and uncovered by the player's hand to get two pitches, say, a fifth apart (photo 8, preceding page).

Finally, this modular pipe design can be used to construct resonating chambers for non-percussion instruments. For instance, eighth inch plywood glued over a drainage catch basin makes a decent kalimba resonator. I've built a nice double kalimba this way (photo 9, preceding page). Stringed instruments should be possible, though I haven't thought up any good designs. One might also try combining plywood headed drums with other instruments that are often built from PVC and ABS — perhaps there's a way of combining a floor drain drum with a 2" ABS didjeridu.

I've sold a few of these instruments in the Denver/Boulder area under the trademark "PipeDrums." While I ask readers to respect the trademark, I've decided not to pursue any other intellectual property in the designs (such as patents) for now. Please feel free to try out these designs and take the ideas in new directions. Happy experimenting!

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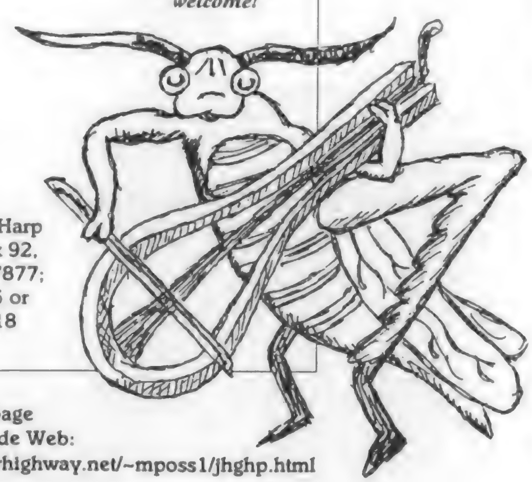

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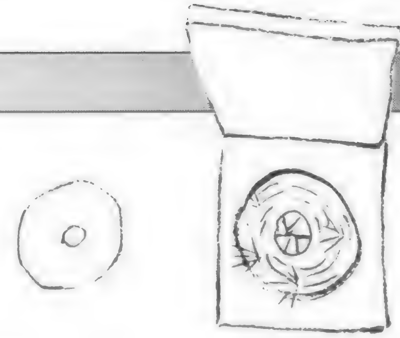


RECORDING REVIEWS

By Warren Burt, Mitchell Clark, Dean Suzuki and René van Peer

MARK APPLEBAUM: **MOUSETRAP MUSIC**

On CD from Innova Records, 322 Minnesota Street E-145, St. Paul, MN 55101-1300 (http://www.tc.umn.edu/nlhome/m111/compfrm). Innova 511

Mark Applebaum's Mousetrap immediately calls to mind the electroacoustic percussion boards built and played by Tom Nunn. Like Tom's instruments it is a kind of table top to which a variety of objects have been attached — 'threaded rods, nails, wire strings stretched through a series of pulleys and turnbuckles, plastic combs, bronze braising rod blow-torched and twisted, doorstops, shoehorns, ratchets, steel wheels, springs, lead and PVC pipe, corrugated copper plumbing tube, Astroturf, parts from a Volvo gearbox, a metal Schwinn bicycle logo, and, indeed, mousetraps' as Applebaum writes in the liner notes to this CD. The instrument is amplified with piezo pickups; the signals are fed through a mixer and electronic processors.

As with Tom's instruments, the Mousetrap family (Applebaum plays four different instruments on this album) lends itself to impromptu explorations into the sounding possibilities of the objects and of different ways of playing them, in isolation and in combination. Several tracks on this CD obviously focus on that aspect, such as "Scrape: Threaded Rods," "Bow: Tam Trees," "Pluck: Koto" and "Strike: Dulcimer Groove." In length they vary from just five seconds to almost half an hour. The latter, called "S-tog," is excerpted from a live piece of ninety minutes played 'in cohabitation with' a performance of the Merce Cunningham Dance Company in Minneapolis, 1993.

In the years that Applebaum worked with these instruments since he constructed the first, he evidently acquired sensitivity in how to approach and use the variation inherent in them. He is not afraid to stick to relatively simple sound patterns for some time, as in "S-tog." At one point he plays the rods (at least that's how it sounds), striking percussive clanks with a hint of pitch from them, juxtaposing these at first with electronic chirpy clicks. Out of the clanks a drone emerges that is interspersed with a diffuse clattery rhythm. While the fast paced clatter gains prominence the drone subsides, then comes on again temporarily, changing pitch from time to time. Later on it re-appears, but only as a faint tonal trace evaporating from rhythms played on the rods.

It would be intriguing to see and hear Tom Nunn and Mark Applebaum play together in duo concerts, to get an opportunity to compare them and find out to what extent the music results from the character of these instruments, and how much individual musicians differ from each other in playing them.

— RvP

CRAWLING WITH TARTS: **SARAJEVO CENTER METAL DOORS**

Realization Recordings RZD-019, available from Realization Recordings, 9452 Telephone Rd., #116, Ventura, CA 93004 or contact Crawling With Tarts, P.O. Box 24908, Oakland, CA 94623

Crawling With Tarts is a San Francisco Bay Area collective. On *Sarajevo Center Metal Doors*, the group realizes their own graphic scores, text scores, and game scores (a la John Zorn?), all with healthy, if not prescribed or otherwise limited, doses of improvisation. In addition to composers Suzanne Dycus-Gendreau and Michael Gendreau, the ensemble includes Erik Bergkvist, Catharine Clune, and Ed Osborn. The instrumentation leans heavily towards found objects and other unconventional sound sources, including tennis ball, gourd, bread pan, victrola, fish bowls, chalices, box of pottery chips, saw blades, corrugated tubes, grill, pastry molds, vent screen retainer, water bottle, prayer stones, beans, styrofoam, bolt + funnel, "door harp & mountain harp," radio grill, truck-flattened disk, vent bezel and kinked wire, helical steel trap, doughnut mold, lamp shade, window weights, motors and much more, in addition to a few more conventional instruments such as violin, harmonica and bass trombone.

The title track is a very long piece based on a four-color graphic score, a portion of which is provided in the CD booklet. Each ensemble member follows his/her own color and is provided information regarding density, dynamics and relative time for each musical event. Other elements or techniques, such as pitch, instrumentation, rhythm, and articulation, are determined by the performers. Finally, each member is provided with excerpts of other Crawling With Tarts music which may be freely excerpted in the performance. The realization here, along with most of the other music on the CD, tends towards the delicate, subtle, nauanced and quiescent. The trend towards restraint is occasionally interrupted by aloud, frenetic outburst, but it might also be punctuated by long, Cageian expanses of silence or, more accurately, unintended sounds.

"1—8 Ideomotors" is scored for twenty-four specified sounds which are divided into trios in which each of the three performers has eight sounds. In addition, there are two extra sounds common to each performer, plus there is a finale with sounds unique to it. While the formal design, including order of instruments and colors, is strictly ordered, there is room for some free exploration and improvisations within the confines of the score. The third and shortest work, "Motors," features sounds which are all generated by small 120 volt AC electric motors, with the one exception of a short-wave radio. Rather influenced by the music machines of Fluxus artist Joe Jones, the armatures of the motors spin against and "bow" various metals and strings. As one might expect, the sounds are mechanical, even industrial, and tend to be louder than those of the other works, though still within a rather small dynamic range and certainly not overly loud. In fact, some of the sounds are rather delicate, though not quite reaching the delicacy, if not limits of audibility of Jones's work.

— *DS*

MUSEE MECHANIQUE: **PLAYER PIANOS AND OTHER SOUNDS FROM A PENNY ARCADE**

LP from Third Mouth Records/La Brea Recordings 3rdMLB 101 (LP). For information, contact Third Mouth Records at 65 Hill Street, San Francisco, CA 94110

Yes, San Francisco has its many charms, its "relics of a bygone day," its Mark Twain quotes. One of its charms, perhaps not too well known, is the Musee Mechanique. In the lower recesses of Cliff House, within ear-shot of the barking seals at Land's End, this little museum is an extensive collection of mechanical musical instruments, including player pianos, orchestrions, nickelodeons, and music boxes. Although a tune in this penny arcade now generally goes for 25 cents, with a high-brow melody on one or two of the fancy European models costing a dollar, an hour or two spent among the coin-operated instruments of the Musee Mechanique is indeed a sound musical investment for one's quarters (a change machine is available).

Many of the highlights of the Musee Mechanique are now available on a recording. *Musee Mechanique: Player pianos and other sounds from a penny arcade* collects together eighteen tunes from instruments "recorded live on location at the Cliff House." Included are such well worn favorites as "Big City Blues," "That Soothing Melody," "Dizzy Fingers," and of course, "Piano Roll Blues." There's even an appearance of the mechanical guffaws of Jolly Jack. Recorded on a vintage 1960 reel-to-reel tape recorder and released as an LP, this album captures the texture of a sonic age gone by.

Included with the LP is an insert with reminiscences by Ed Zelinsky, who founded and owns the Musee Mechanique. Mr. Zelinsky has been an avid collector of mechanical musical instruments, as well as antique slot machines and animated photo viewers, for many years — as he says, "since I was 11 years old, and that's a long time ago."

Now, one might say that this album is "the next best thing to being there." A visitor to a penny arcade of orchestrions and nickelodeons may find that some (many?) of the instruments will be slightly (greatly?) out-of-tune at the time of one's visit. It certainly comes with the territory, but it's also part of the charm. On my recent visit to the Musee Mechanique, an occasional sour note didn't spoil things at all. For one thing, watching the instruments chugging away at work is part of the fun. But if you want all your player-pianos and orchestrions in pretty good tune, well then, the album might do being there one better.

— *MC*

LES PHÔNES: **MYTHES ET LÉGENDES PHÔNES**

On CD from Audiorama. B.P. 161, 67004 Strasbourg Cedex, France; or from Pays des Phônes Asbl, 26A rue St Gilles, 4000 Liège, Belgium, phone +32 41 230190. Audiorama Long 03

Les Phônes are a Belgian trio playing acoustic instruments that since 1987 have been designed and built by two of its members, Jean-Claude Charlier and Franck Pillonetto. Four of these are percussive; one is a wind instrument. This latter is played by walking. Called Stiltophone, it consists of stilts, each with two tuned pipes attached. Putting a foot down makes a piston pressurize air, which is released through the pipes. When the entire group uses them, they go hocketing around, giving the music an attractive bounce. The Pongophone is a slab the size of a pingpong table; one version is made of glass, another of aluminum. They can be played with mallets, but also with pingpong balls which create random rhythms and melodies. In some very gratifying moments both are used in combination — the music acquires a definitely uncommon indeterminacy and ambiguity, something which I find quite enjoyable to listen to.

Two instruments, the Héliophone and the Anthémophone, use metal rods of different lengths arranged in a circle for sound production. With the latter it is not exactly clear how they are played. The former rotates and can be beaten with a stick. It can also play automatically by a ball placed within the circle. Finally they sometimes use Rain Columns, series of cones that sound as if grains of sand or small stones fall through in a protracted rustle, rather than drops of water.

Most of the tracks feature the instruments separately. In *Le Premier Monde* they are used in conjunction. This piece has been conceived around the Stiltophones. They form a windy frame in which the tinkling of the other instruments is inserted from time to time. Again, there's lots of hocketing, but also sustained notes and repetitive, interlocking lines. The effect is soothing, but always appealing.

— RvP

C. REIDER: **GRIME**

Cassette and booklet with graphics for $5 US from C. Reider, PO Box 1294, Lyons, CO 80540-1204

Have you ever been wandering around, and seen a pile of scrap cassette tape fluttering in the wind, and wondered, "I wonder what's on that?" C. Reider did also, but in his case, he did something about it. Advertising through the international mail art network for contributions, over a period of two years he received material from 89 people world wide, consisting of scraps of cassette, reel to reel, video and 2-inch (!) audio tape. These were all sliced to cassette size by Reider, who then proceeded to splice fragments of them together using adhesive tape (not splicing tape) and a ruler. Four tapes were made in this way, and they were mixed to make the final 30 minute (15 minutes per side) cassette.

As can be expected, the sound quality of the cassette is suitably scungy and lo-fi — a recording engineer friend I played part of the tape to described the sound quality as "disgusting" with a smile that spread across his face from ear to ear - and, as a study in sonic decay, it's fascinating. Fans of bad science fiction and members of religious fundamentalist groups will be pleased with the found quote near the beginning of the piece, "Legend has that it was written by the dark one: Necronomicon ex Mortis." How comforting to know that so-called "satanic messages" can still be found at random on scraps of tape around the world! More interesting than just the sound collage itself, which does have some very nice sound surprises, is the work as a whole. The package consists of cassette, an essay by Reider describing the project and what the structures he used to splice the tape together were (showing what kinds of "randomness" he was using in making the piece), a listing of all participants, two pages of comments (in tiny type) from the participants describing how and where they found their tapes, some very droll xerox graphics by Jon Stangroom, and a small fluorescent magenta slip stapled to page one of the brochure stating very clearly, and desperately, that the project is absolutely and completely over, and begging for people to not ever send Reider disembodied cassette tape ever again. As an occasional participant in the international mail-art network who has watched projects get out of hand more than once, I can easily share his feelings. People who are interested in the results of this

low key and lo-fi international experiment in exploring what sounds people were throwing away between 1993 and 1994, and seeing the range of responses Reider got to his request, would be well advised to write to him. The package of material (cassette and booklet) is a mail-art fan's delight.

—*WB*

AKIO SUZUKI: **STONE**

Catalog (30 pages) with CD. ISBN 3-89357-047-0. From Berliner Künstlerprogram des DAAD, Jägerstrasse 23, 10117 Berlin, Germany

The Japanese sound artist Akio Suzuki has a fascination for stones. He shares this with a host of other people — in various senses. First, I don't know anybody who doesn't enjoy walking along the waterside, looking around for wonderful samples. To take them home, to throw them into the water, to have them skim over the surface. At the age of three my daughter Esther just loved the pebbles in Trimpin's *Liquid Percussion*, the last installation to be exhibited in Het Apollohuis. She went home with her pockets stashed full of them.

Then, Suzuki is fond of stones, and he loves to give them to friends of his who share this love with him. In return he receives extraordinary stones from his friends. In the first text of this catalog he writes about his stone flute, which was a present from his father. It is an object with an unusual shape, like a trapezoid with one corner broken off and many holes. It is also an object with a history, of which Suzuki gives the reader a few caring glimpses. The second chapter is the introductory text to an installation with stones that he made in Künstlerhaus Bethanien in Berlin. In it he tells about the connection of his love for stones with his work as an artist. The installation is also documented in photographs and sketches. The third and last chapter is about his 'collection of stone collectors.' Yumiko Urae and instrument builder Martin Riches did a great and loving job preparing and translating Suzuki's texts, originally written in Japanese. They managed to retain the combination of thoughtfulness and lightheartedness that is characteristic of him.

The CD consists of eight explorations into the sound possibilities of stones. Most of these involve Suzuki's flute. The opening track is one glissando of 27 seconds. In other pieces he follows lines that remind one of shakuhachi music, with its contemplative moods, its use of overblowing, the long drawn out notes and the insertion of small motifs that may stem from signal calls. This stone flute (and this must also be due to the way Suzuki plays it) sounds far less breezy than the Japanese bamboo flute, although the hiss of Suzuki's breath does soften its tone. Three tracks explore various ways in which stones can be used as percussion. One of these sounds as if Suzuki opens and closes the hand in which he is holding one stone, beating this with another in rapid rhythms. The natural reverb of the space where the recordings were made plays a prominent role in the music. The echo seems to give Suzuki opportunity to reflect on the sounds he produces, and to go after them, incorporating cause and effect in one and the same event.

— RvP

SYNAULIA: **MUSIC FROM ANCIENT ROME, VOLUME 1**

CD from Amiata Records (Italy) ARNR 1396

Music from Ancient Rome is the first in a series of releases, by the Italian ensemble Synaulia, of reconstructions of music of ancient Rome. Directed by Walter Maioli, who is also a featured musician, Synaulia presents music for a variety of ancient Roman wind and percussion instruments. These instruments are known through iconographic and archaeological evidence, and have been reconstructed for this project. The compositions are modern, mostly by Maioli, and attempt to evoke this music of antiquity.

Walter Maioli is also the force behind The Art of Primitive Sound and their album *Musical Instruments of Prehistory* (which has been reviewed in *EMI* by René van Peer in Vol.9 #1, and discussed briefly by myself in a review of *The Sounds of Prehistoric Scandinavia* in Vol.12 #2). As with *Musical Instruments of Prehistory*, all of the music on *Music from Ancient Rome* is newly composed. Unlike ancient Greece, with its fair-sized corpus of notated music from the fifth century BC through the third century AD, Rome of antiquity is virtually without musical notations.

One item which is quite interesting (although the results shouldn't come as too much of a surprise) is track 7, "Imperium," which calls forth a military band of brass instruments. The instruments featured are the lip-vibrated brass instruments *cornu* and *tuba*, together with some supporting wind and percussion instruments. As the pitches which these instruments produce are those of the natural harmonic series, and a duple-time marching pace — the tromping of troops — is emulated, this ensemble sounds not unlike a modern drum-and-bugle corps (and the swirling supporting flute figurations remind one of the piccolo in Souza's *Stars and Stripes Forever*). The thing is, what Synaulia has presented may indeed be quite close to what such an ensemble would have sounded like some two thousand years ago. Just by virtue of the properties of the instruments and a certain context for thier use, an unexpected continuity is established, over the course of a couple of millennia, in a musical ensemble which we might be tempted to think of as being fairly mundane. As lip-vibrated instruments featuring natural harmonics are featured in the following two tracks — #8, "Diana," and #9, "Arena" — familiar-sounding hunting horns and fanfaring trumpets, respectively, are evoked as well.

But these examples, and others, do beg the question: to what extent might Synaulia be starting at the present and working backwards, so that if we may draw a picture of continuity with the past, it is with a past which is being imagined to be like the present? Walter Maioli's work — and that with The Art of Primitive Sound is another example — strikes me as the larger part intuitive, the lesser part archaeological. When his work is successful, it is because it is successful as sounding music. The intuition seems colored by the archaeology, but not bound to it, and may well produce something based more on the familiar than on the "evidence." But, one has to start somewhere; one does have to start with things at hand — existing traditions, for instance — to use as clues. For example, the tracks (nos.12 & 13) which have *tibia* performances, especially no.13, "Tibiae impares," seem to have started, perhaps, with Sardinian *launeddas* and worked backwards to a supposed "rougher" instrumental style which makes use of simpler melodic gestures than does the modern bravura style of *launeddas*. Again, it's a place to start.

The album is very handsomely packaged as a small book, with many color photographs and reproductions. Some of the specific information about the musical selections and the instrumentation used, however, appears to be garbled. For instance, the listing of the players together with which instrument(s) they play on which track would be helpful information, except that it doesn't always

correspond to what one's hearing. Multiple tracking appears to be used in several of these recordings. This may not make much of a difference at the listening end, but this fact does detract from creating the feeling that the various ensembles we're hearing are fully living musical entities. These details aside, the results on *Music from Ancient Rome* seem to be well considered and plausible, and at times make exciting music.

— *MC*

EMIL RICHARDS: **WONDERFUL WORLD OF PERCUSSION**

Interworld CD, CD-914 from Interworld Music Associates, RD3 Box 395A, Brattleboro, VT. 05301

JOHN HERRON: **SCHEMES OF RHYTHM**

($6 + $1 S/H) from John Herron, 3635 S. 544 E., Salt Lake City, Utah, 84106

Here are two very pleasant and listenable albums of percussion, one from an extremely well known percussionist, and one from a lesser known one. Emil Richards is one of the world's best known and most heard percussionists. Working for decades in the Los Angeles film music scene, he has built many instruments for film sound tracks and other projects, and worked with just about everyone in the California scene from Harry Partch to James Horner. Working on other people's projects however, has left him little time for his own, and this is his first solo CD. It's one of the jolliest albums I've heard in quite a while. A series of light-hearted jazzy tunes, in which Richards plays all the parts, (and which are immaculately recorded) provides the vehicle for an astonishing variety of timbres and textures. The liner notes give a listing of all the instruments used on each track, and there are several photos of the more adventurous instruments, such as the ContraBass Marimba(heard on track 3, "Sheep Lie," (a set of variations on the changes of Waller's "Jitterbug Waltz") where it plays a discreet jazz bassline, and on track 9, "Amos," where it makes a lovely contrast to the high sleigh bells and Deagan Organ Chimes, or Metal Angklungs). The overall feeling of the album is happy — there's not an ounce of angst to be found here — and familiar. Richards is obviously enjoying himself very much, both in his delightful jazz soloing, and in assembling his impressive collection of percussion into textures and timbral collections that convey this enjoyment to the listener.

Less well known is John Herron, from Salt Lake City, but I found *Schemes of Rhythm*, his cassette, equally enjoyable. The mood here is darker than on Richards' album (I don't mean to say that this album is gloomy — it isn't — but after all the emotional sunniness of Richards album, anything would appear darker). Herron's timbral exploration, however, is equally wide ranging. Involved here are involving what sounds like a number of unusual processing techniques, such as those Herron discussed in his article in *EMI* Vol 11, #3. What I find most appealing about this album is the clarity of his textures. In most of the tracks, he sets up a simple pulse or repeating riff, and then plays other textures, usually two or three of these, against the riffs. The riffs are usually played on familiar timbres, and their rhythms are quite simple, so they quickly become "transparent," allowing the other textures to be heard as polyphonic lines against them. The quality of these "background" sounds (often at the same level as the foreground riffs, but seeming in the background because of their less repetitive nature) is often extremely subtle, and wide ranging. Often, sequences of different tone colors will appear as if out of nowhere — a particularly appealing one occurs near the middle of side 2, with a lovely sequence of shakers, Speak'n'Spell computer voice, toms, etc. weaving in and around the other musical lines. Track 3, "Intestinal Jazz," is a particular favorite. Here the foreground texture is made of pleasant "plucked" sounds, while the background consists of various gliding tones made with a variety of sources. Herron has figured out one way of having a poly-textural music where each of the textures can be clearly heard in its own right. This would be accomplishment enough, but when it's done with percussion-and-electronics music as enjoyable as this, the results are doubly delightful.

— WB

MACHINE FOR MAKING SENSE: **TALK IS CHEAP**

CD (#CD 4) from Split Records, PO Box 445, Potts Point, NSW, 2011, AUSTRALIA

JIM DENLEY AND THE RANDOM MODULE TWINS: **SONIC HEIROGLYPHS FROM THE NIGHT CONTINENT**

CD (#CD 3) from Split Records, PO Box 445, Potts Point, NSW, 2011, Australia

BRIGID BURKE AND RAINER LINZ: **INTERSECT**

NMA CD9706 from NMA Publications, PO Box 34, Burnley, VIC. 3121, Australia

LE TUAN HUNG AND DANG KIM HIEN: **LANDSCAPES OF TIME: CONTEMPORARY SOUND ART OF VIETNAM**

CD MD3197 from Move Records, PO Box 266, Carlton South, VIC. 3053, Australia

Despite the near collapse of the Australian economy, and savage cuts in government spending on the arts, broadcasting, health, and education, somehow, experimental music in Australia remains alive and kicking, if not exactly financially healthy. Here are four recent CDs, all of which received some help from the Australia Council, the government arts funding body, which reflect some of the liveliness and imagination of Australian experimental musicians.

The Machine for Making Sense is a group consisting of poets/vocalists Chris Mann and Amanda Stewart, wind player Jim Denley, string player Stevie Wishart, and electronicist Rik Rue. They've been performing together for eight years, and have developed a taut interplay that sometimes leaves the listener breathless. Both Mann and Stewart write highly charged and compressed political poetry, which is delivered in unique and highly articulated ways. Both become, at times, the engine that drives the Machine — their rhythmic and highly energetic reading becomes a kind of manic drone — and this drone's choppy texture provides rhythmic and aesthetic templates to the rest of the group. At times, the work of the Machine can be quite dark, reflecting a view of an ideologically fractured world where fragmentation and conflict are eternal. At other times, it can be completely engrossing. On the current CD, their second, for example, track 3 features a duet for the two poets simultaneously reading their works that is one of the most breathtaking examples of current sound poetry, while the playing of Stevie Wishart on hurdy-gurdy is of such variety that she practically redefines the instrument single handedly and places it squarely into the repertoire of contemporary improvised music. Her duet with Rik Rue (who has refined the live mixing of sampled sounds to a high art) on track 11, is nothing short of amazing. And the two duets with wind player Jim Denley (track 13 with Mann, track 17 with Stewart) are definitive statements about combining vocal and wind instru-

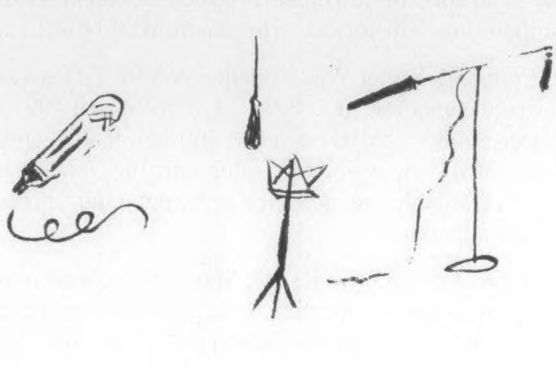
ment sounds. Interestingly, European reviews of the Machine describe them as American, while American reviews describe them as European. This only shows the difficulty people have in coming to grips with the nature of contemporary Australian art, which draws from both sources (and others)while maintaining its own unique identity. For me, the sound of the Machine is THE defining sound of Australia.

Jim Denley also appears on a new solo CD, where he plays with "The Random Module Twins," an electronic system of his own devising, consisting of two mini-disc players placed in shuffle mode. He records mini-discs especially for each section, each with tracks of sound and tracks of silence. In performance, the two players playing tracks in random order provide an unpredictable accompaniment for him, but one where he has chosen the material to be presented randomly. This affects his improvised responses, making his solo performances more like group improvisation than solo presentations. What is surprising about this album is that, despite the intellectual sound of the process just described, the music has a lush, almost romantic feel to it. Living in the heart of Kings Cross, Sydney, the most densely populated urban area in Australia, Denley has produced an album of absolutely contemporary music that contains some of the most romantic musical nature poetry I've encountered in quite a while. At first, I thought that the titles of the tracks (which when taken together, form a poem about the Budawang mountains on the south coast between Sydney and Canberra) were merely fanciful, but on subsequent listening, I began hearing them as absolutely appropriate descriptions of the musical content. Denley is in fine form here, traversing as complete and encyclopedic a range of extended wind techniques as one could wish for, but here the techniques are used in the service of a poetic vision of landscape that both refers to the ongoing engagement with landscape that has been a constant feature of Australian art for about the past 20,000 years, and also deals with contemporary ideas of structure in a refreshing and original way.

Rainer Linz and Brigid Burke are both known to readers of *EMI*, Linz for his description of Percy Grainger's Free Music Machines (in Vol 12 #4),and Burke for her work with Extended Wind Instruments (in Vol 9 #2). Here, they team up to work with a Sensorlab system from the Dutch STEIM studio, electronic systems of Linz' devising, and Burke's very fine control of microtonal inflection and timbral exploration in a series of interactive compositions where Burke's playing is used to provide information to the electronics, influencing what it plays in response to her input. Some of the works, such as "Physic," the first track, are extremely subtle — Burke plays a series of long, microtonally inflected tones, and the electronics respond in a variety of ways, while others, such as "Shout!" (track 2), are wild, with the clarinet rapidly changing register, timbre, attack, dynamics, voice and duration, while the electronics match her playing with its own highly variable texture. Three of the pieces use the ASP system devised by Linz and composer Alistair Riddell. This system uses a computer to control analog synthesizers, continuing Percy Grainger's Free Music work with gliding tones. This is most effective in Asp 3, where Burke bends her clarinet sounds to match the bending and swooping of the electronic tones. Riddell also appears as a (compositional) guest on the album, in "NeXT Fix." Here he processes a performance of Linz' and Burke's "Duet" (a composition where her solo playing on Yamaha WX7 wind controller is extended by the electronics into a polyphonic accompaniment) into a tape that they then use as a further element in their performing. Humor also appears here, especially in "Walk On Parts," a Linz composition (here electronically augmented) which slyly winks at the opening clarinet riff of Gershwin's "Rhapsody in Blue." Many composers and performers seem to be exploring interactive processes with electronic systems recently. "Intersect" is a strong and attractive addition to this field.

Le Tuan Hung and Dang Kim Hien are composer/performers from Vietnam who now live and work in Melbourne. Le Tuan Hung is a virtuoso on the dan tranh, the Vietnamese zither. He is well known both in Australia and overseas for his work with that instrument, his improvisational work with a wide variety of contemporary musicians, and his musicological work on Vietnamese music. Dang Kim Hien is also a virtuoso on the dan tranh, and as well, is a stunning singer. Her recordings of unaccompanied Vietnamese Lullabies on their previous album of Vietnamese traditional music (*Echoes of Ancestral Voices*, Move MD3199) are astonishingly beautiful and haunting. In this album, the emphasis is on their own compositions, which combine elements of Vietnamese tradition with an absolutely contemporary compositional sensitivity. In her moving "Silent Tears," for example, Dang Kim Hien attaches a Shadow SH2000A transducer to her throat to pick up the most minute of vocal sounds, accompanying herself with bamboo block and chopsticks, while Le Tuan Hung adds contrasting lines with a suling (a Balinese flute). The use of non-Vietnamese instruments is also a feature of "Longing for the Wind," a Le Tuan Hung composition which uses Tibetan and Mongolian harmonic singing techniques, whirlies, and environmental sounds as well as traditional Vietnamese string instruments. For me, the prize of the album is the collaborative "Webs of Life," a collage soundtrack for an audio-visual event made in collaboration with painter Nguyen Van Doi. Environmental sounds, percussion, simple electronic generators, and a wide variety of strings, wind and percussion instruments are combined into an episodic work that wanders gently through many different sonic areas. In an era where a resurgent racism is threatening to tear apart the multi-cultural fabric of Australian society, the work of Le Tuan Hung and Dang Kim Hien stands as a beacon, showing how elements of tradition and contemporary exploration can be successfully combined into works that speak to both past and present. This album shows them as valued and important members of the Australian compostional community.

—*WB*



Recent Articles in Other Periodicals

The following is a list of selected articles relating to musical instruments which have appeared recently in other publications.

"Introduction to Foot Percussion" by Niles Hokkanen, in *The Mandocrucian's Digest* #27, Spring, 1997 (PO Box 3585, Winchester, VA 22604).

The author has been developing foot percussion set-ups to provide percussion accompaniments while playing other instruments with his hands. This article is only minimally about his set-ups; it's primarily about developing playing skills, with suggested rhythms and practice drills. (We're hoping to get an article from Niles on his rather ingenious foot-percussion set-up in a coming issue of *Experimental Musical Instruments*.)

"The Mutantrumpet of Ben Neill: Where the Scientific and the Mystical Meet," Chris Twomey interviews Ben Neill in *Musicworks* 68, Summer 1997 (179 Richmond St. West, Toronto, Canada M5V 1V3).

Ben Neill created and plays the mutantrumpet, an altered trumpet with three bells, extra valves, and a trombone slide for acoustic play, and which in addition has been set up as a MIDI controller with its own software and hardware. In this two-page interview he discusses a recent, elaborately MIDI-controlled multi-dimensional mutantrumpet performance, the experiential nature of tuning explorations, and other topics.

"Turn Down the Illusion," Daniel Goode interviews David Demnitz, also in *Musicworks* 68 (address above).

A wide-ranging discussion with educator, composer and long-time member of New York's Gamelan Son of Lion David Demnitz. For *EMI* readers an interesting facet of this interview will be comments on how the gamelan as an ensemble of instruments functions in various arenas as a social entity, a pedagogical tool, an organizational focus, a compositional grounding.

"The Quarter Tone Recorder" by Donald Bousted, in *The British Harry Partch Society Microtonal Newsletter,* Vol 2 #3/4, Feb/May 1997 (33 Arthur Rd., Erdington, Birmingham B24 9EX, England).

A recorder player tells of his interest in quarter tones and the development of quarter tone fingerings for the instrument.

"Fabriquer une Sanza" by Michel Faligand, in *Percussions* #49, Jan/Feb 1997, rue Théodore-Rousseau, F-77930 Chailly-en-Bièrre, France).

Illustrated instructions for making a sansa of the type *busoga*, of South-East Uganda. [in French]

"Ben Franklin's Musical Invention" by Valerie A. Russo, in *Glass Music World 10th Anniversary Edition* (2503 Logan Dr., Loveland, CO 80503).

A very brief history of the glass harmonica, from Ben Franklin to the contemporary maker Gerhard Finkenbeiner.

Logos-blad (Kongostraat 35, 9000 Ghent, Belgium) is the newsletter of Stichting Logos, a center for adventures in new music and sound exploration in Ghent. The articles in the newsletter are mostly in Dutch; more rarely in English. *EMI* has failed to note many undoubtedly fine articles from *Logos-blad* because *EMI's* editor can't read Dutch. But to give readers a sense of the kinds of things that turn up, here's a selected sampling of articles from the April, 1997 issue of *Logos-blad*: a short piece on the American junk musician Donald Knaack, who works entirely with recycled materials; something on the Dutch maker of wind-sound devices Horst Rickels, and a page on activities of the Logos Duo (Moniek Darge and Logos director Godfried-Willem Raes), decorated with drawings of what appear to be manual phonograph disk transducers (hand-held paper soundboards with needles attached).

Noisegate #5 (150 Scott Rd., Pitsmoor, Sheffield, S4 7BJ, England) contains several reports on recent sound events and installations in England and the continent, including an exhibit at Midlands Art Center called *7/8 of a Second*, a set of pyro-sound performances and exhibits at the Bond Gallery in Birmingham called *Slow Burn*, an installation at Sheffield Hallam University Gallery called *Testing '96*, and the *Sonambiente* sound art festival that took place in Berlin, Summer 1996.

*A*merican Lutherie Number 48, Winter 1996 (8222 South Park Ave., Tacoma, WA 98408-5226), contains articles on the construction of guitars and other stringed instruments, including —

"Stage Acoustic Guitars," by John Calkin: procedures for making quick and simple, but functional guitars of the sort that are made to sound and play like acoustic guitars but at the same time are designed for use with a built-in pickup.

"Prepare to Meet the Maker: Fred Carlson," by Tim Olsen: An interview with a maker known for combining discipline and skill with whimsy and innovation.

"Wood Identification for Luthiers," by Nicholas Von Robison: A guide to resources in the field of wood identification.

"The Concert Zither" by John Roeder, in *American Lutherie* #50, Summer 1997 (8222 South Park Ave., Tacoma, WA 98408-5226).

A discussion, with complete mechanical drawings, of the construction of a type of zither that was most popular in Germany and Austria in the late 19th and early 20th century, having a fretboard under several strings alongside a wider array of unfretted strings.

Also in *American Lutherie* #50 (address above): articles on many facets of guitar construction.

Instrumentenbau Report (Lärchenstraße 23, D-85604 Zorneding, Germany) is a German magazine of practical information for makers of all sorts of instruments. Issue #22 contains information on bamboo flutes, historical string instrument bows, and more.

IndieVisions (95 Yesler Way, Seattle, WA 98104) is a newsletter "for artistic technologists." Issue 11, Feb/March 1997, contains articles on robotics, MIDI controls in non-musical applications, and solenoid valves, as well as products profiles relating to various new and affordable technologies with potential applications in artistic installations.

CAS Journal Vol 3 #3 (Series II), May 1997, contains articles on acoustics of string instruments, including one on air resonance modes in harps, one on wood resonances in violins, and several more.